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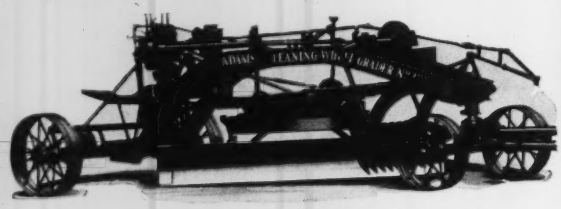

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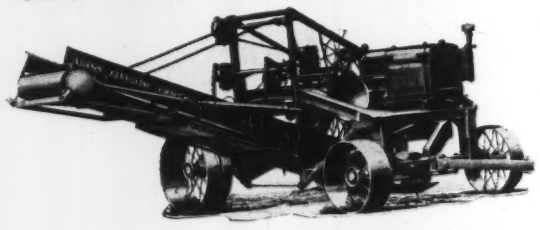

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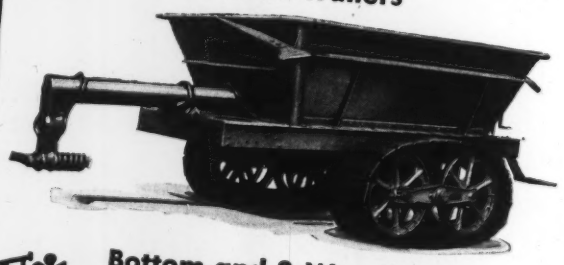

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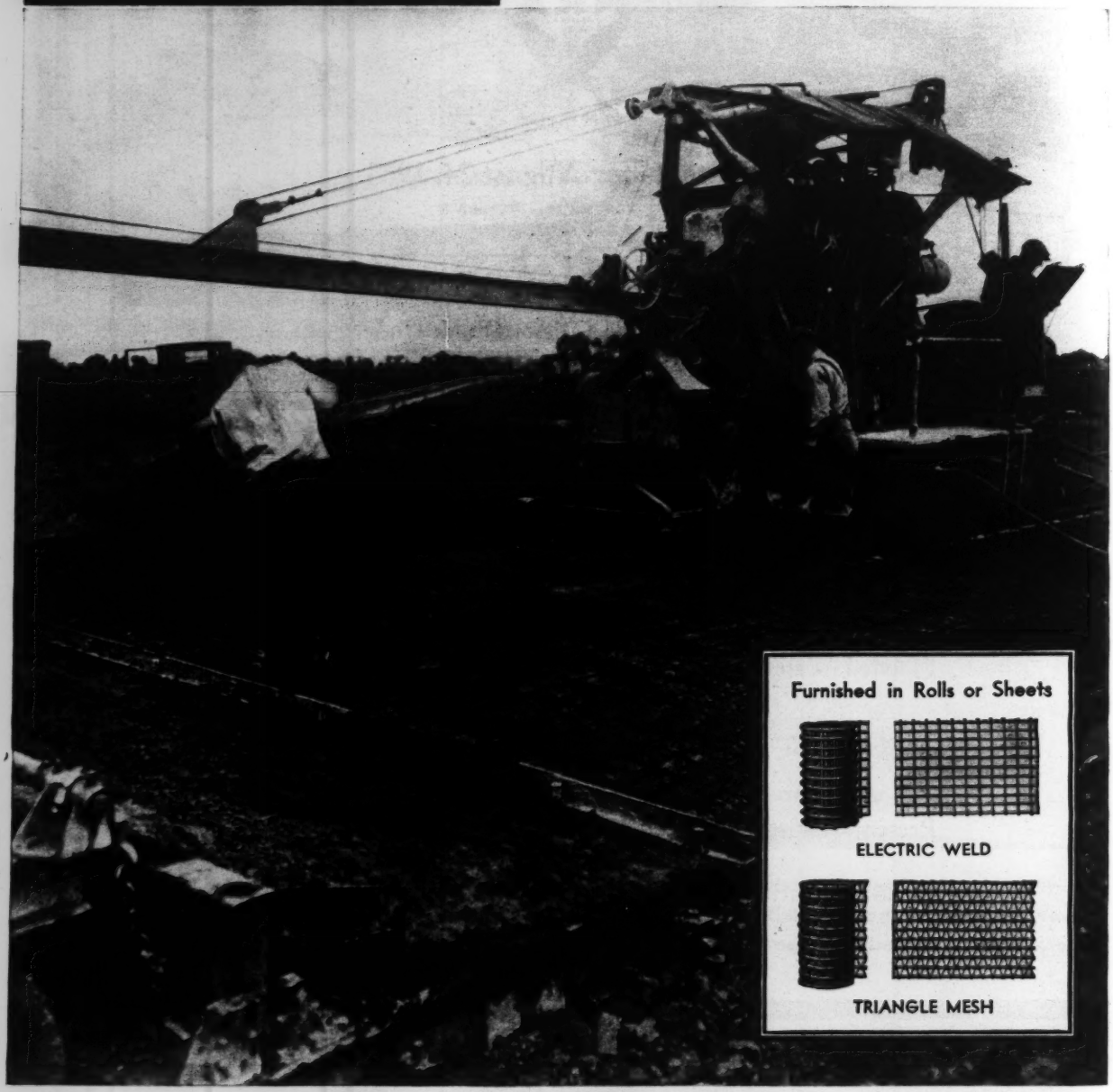

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Corewall of 31 Caissons Sunk Under Air

Concrete caissons 9 x 45 ft. sunk end to end, 140 ft. maximum to bedrock—Pumping ahead of construction lowered groundwater level 80 ft. and reduced air pressure to 18 lb.—Trial caisson sunk before pumping required 48 lb. of air

A CONCRETE corewall about 1,500 ft. long, formed by sinking pneumatic caissons to depths of 40 to 140 ft. below original ground surface, is an outstanding construction operation in the new works for additional water supply for the metropolitan district of Boston. This corewall is a part of an earth dike being built to close a depression in the hills surrounding the Quabbin Reservoir, which is to be formed by the Quabbin Dam and dike, the former an earth dam 170 ft. high above original surface and 2,340 ft. long and the latter an earth dam 135 ft. high and 2,140 ft. long. At present only the corewall and preliminary earthwork supplementary to construction of the dikes are in progress. Contracts have yet to be let for the dike embankment and for all work on corewall and embankment for the main dam. This article describes the dike corewall construction alone.

Project reviewed

To orient the reader with the project as a whole, it should be stated that the metropolitan water district under the Metropolitan District Commission is composed of twenty municipalities, including Boston, having a combined population of 1,600,000; fifteen other municipalities, with a population of 400,000, are eligible for inclusion when they desire to take action under the law. The need for providing additional water supply became apparent some fifteen years ago, and two commissions were appointed under authority of the state legislature to study means. These commissions reported in 1922 and 1926 respectively. In 1927 the Metropolitan District Water Supply Commission was created to build the new water-supply structures.

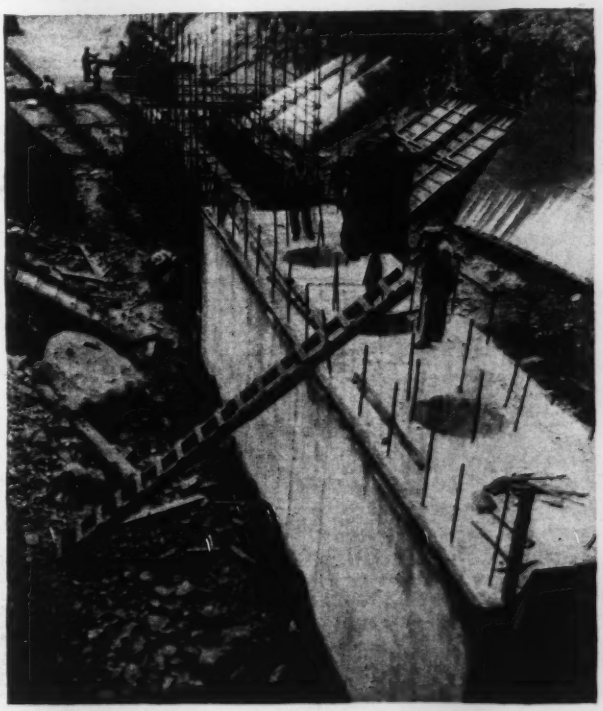


Fig. 1—Sinking pneumatic caissons for corewall of dike that is being constructed at gap in hills rimming Quabbin Reservoir of the Boston metropolitan water supply.

The commission went for its main source of new supply to the Ware and the Swift rivers, about 50 and 65 miles west of Boston. As these streams flow into the Connecticut River, only floodwaters from the Ware can be impounded, and a guaranteed minimum release must be maintained from the Swift. The plan was to connect the new source with the existing Wachusett Reservoir near Worcester, about 40 miles west of Boston. The works included a tunnel 24.6 miles long, from the Wachusett Reservoir to the new Quabbin Reservoir formed by the Quabbin Dam and dike on the Swift River. The tunnel was built first to the Ware River, 14 miles, where a diversion dam

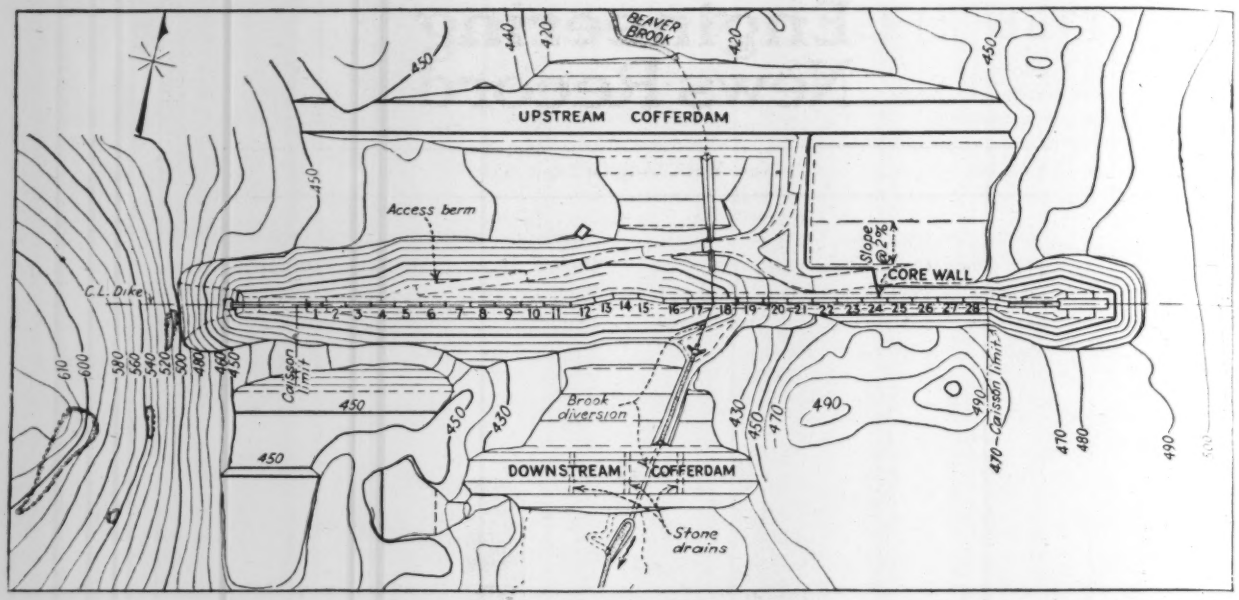


Fig. 2—Plan of Quabbin dike, showing corewall of concrete pneumatic caissons sunk and sealed to bedrock.

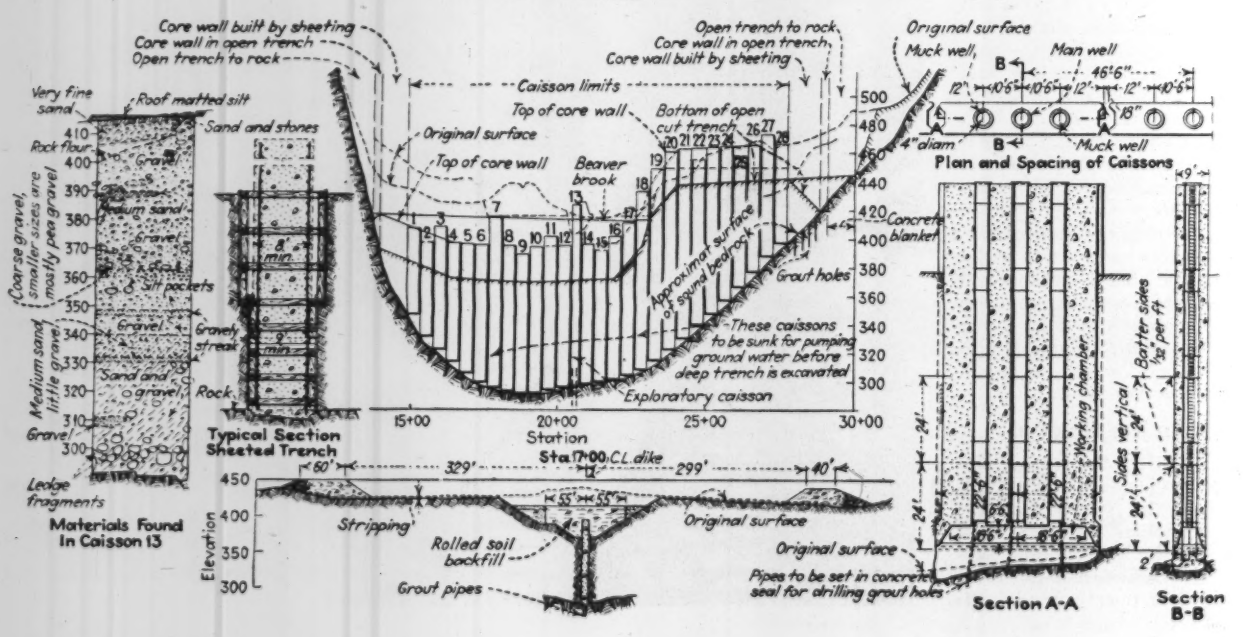
and control works were constructed. This tunneling operation was described in *Engineering News-Record*, Sept. 11, 1930, p. 420. The second section of tunnel, about 11 miles long, is now under construction and will be described in a subsequent article. The main Quabbin Dam, as stated, has not been begun, but the diversion tunnel to be used in its construction has been built and was described in *Engineering News-Record*, July 28, 1932, p. 107.

Corewall structure

The general plan of the Quabbin dike structures is shown by Fig. 2. As shown, the corewall consists of 28 caissons flanked at each end by corewall extensions in sheeted and open trench. These details are more clearly indicated by Fig. 3. In place of the sheeted trench at the east and west ends the contractor chose to sink three more caissons so that, as built, the corewall includes 31 caissons. As shown by Fig. 3, the caissons are 9 ft. wide and 45 ft. long and are sunk end to end with a space of about 18 in. between ends in addition to the spaces formed by recesses in the ends of each caisson. These spaces are to be excavated and filled with concrete keys at a later date.

All essential structural features of corewall and caissons are shown by Fig. 3. The caissons, 45 ft. long and 9 ft. wide, are solid concrete except that two muck shafts and a man shaft and, at the bottom, a working chamber, are cast into the structure. The cutting edge of the caisson is steel, but all the remainder is concrete fairly heavily reinforced around the perimeter of the shafts and around the working chamber. Ultimately, the working chamber will be sealed with concrete and the shafts filled with impervious soil. When completed, the corewall will form a continuous waterstop down to bedrock in the overburden of the valley to be closed up by the dike.

Fig. 3—Profile and section of caisson corewall for Quabbin dike and details of caissons, materials penetrated and flanking walls.



Borings across the valley on the line of the dike disclosed an almost pure sand, gravel and boulder drift down to the ledge-rock line, as indicated by Fig. 3. Virtually, groundwater level was at the surface in the bottom of the valley, and the sides of the bordering hills showed springs. Penetration of the drift overburden was almost a subaqueous operation. On these facts was based the decision to plan a corewall of pneumatic caissons. Before letting contracts, however, further investigation by sinking a trial caisson was decided on.

The trial caisson was 12x32 ft. and was located (No. 13) in about the deepest part of the valley. Being near the bed of the creek this caisson carried air from the start, and toward the end of the operation a maximum presure of 48 lb. was used. Pumping from the caisson when partly sunk allowed the sinking of an open sump near by in the dry, from which pumping was conducted during the remainder of the sinking of the caisson. The material penetrated is shown by Fig. 3. In general, this caisson may be classed among the hard ones of the total number. Boulders that had to be blasted were frequent. The operation, however, demonstrated that caisson construction of the corewall was entirely practicable. The work was done under contract by the Dravo Contracting Co., Pittsburgh, Pa.

In this trial caisson the design provided for several pump suction pipes through the bottom seal. As soon as the caisson was finished, these pipes were connected to two 1,000-g.p.m. pumps. From Aug. 1, 1932, until the main contract was let in January, 1933, the pumps were operated continuously at about 1,700-g.p.m., leading the discharge well away from the site. By the time bids were received this pumping had lowered groundwater level 30 ft. in the center of the valley. A series of observations of well points sunk across the valley disclosed that this subsidence extended up the valley and up the hillsides in corresponding measure.

As planned by the contract, caissons 7 and 18 were to be pumping caissons. The contractor was left free to choose different pumping points but selected those planned, putting down caisson 18 first, from which he worked up the hill and toward the trial caisson 13. With this side completed, caisson 7 is to be sunk and work carried on therefrom toward the trial caisson and toward the opposite hillside. With the sinking of caisson 18, two 4-in. pumps were installed and six pumps of 800 g.p.m. replaced those formerly in caisson 13. With this additional capacity, pumping roughly 3,500 g.p.m., groundwater has been lowered about 50 ft. below the 30-ft. stage reached in the former pumping period, making a total change of stage from nature of 80 ft. The effect of this change on working conditions is mentioned later. Other profitable data were obtained by sinking the trial caisson at the dike. The commission engineers have sunk also a like trial caisson at the main dam, from which pumping operations may be similarly conducted.

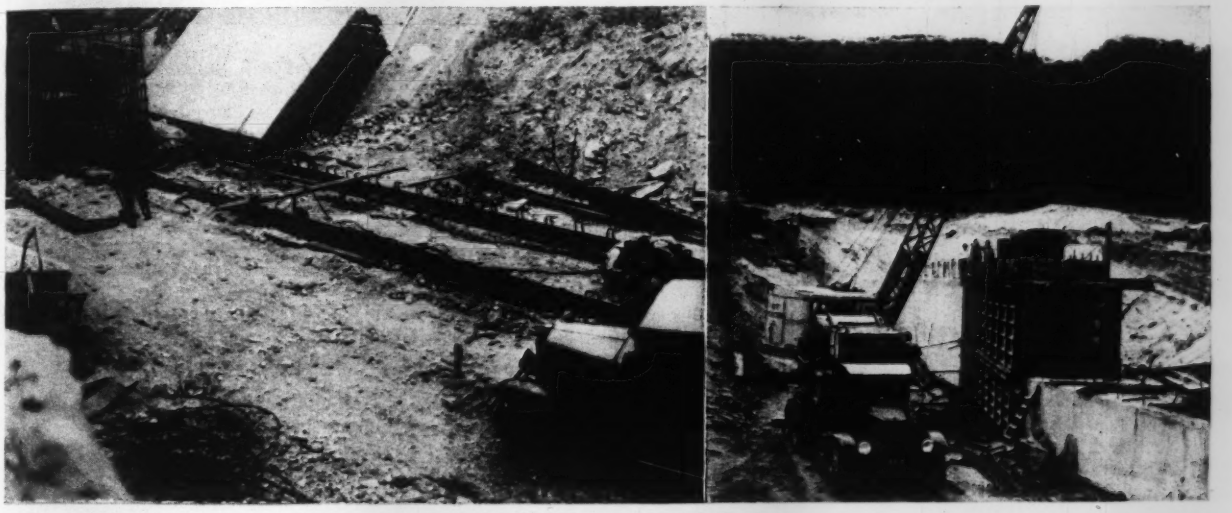


Fig. 4—Welded steel shoe or cutting edge for corewall caisson being assembled in position for erection of working-chamber forms. At the right, a caisson shaft shows type of steel forms used.

Caisson sinking

The importance of the pumping results was reflected in the bidding prices, which were exceptionally low for the character and type of work, and in the saving of costs of high air pressures. In sinking the trial caisson, pressure as high as 48 lb. was used; so far, in sinking about half the caissons, with the water level lowered, not over 18 lb. of air has been required. In some of the caissons yet to be put down, in particular caissons 7, 8 and 9, it is anticipated by the commission engineers that higher pressures up to 25 lb. may be required, but the contractor expresses confidence in being able to keep the maximum at 18 lb. This is a critical pressure point.

Under the legal code for compressed-air work in Massachusetts, 18-lb. pressure is the breaking point in the wage scale. Up to this pressure normal hours and wages prevail; beyond it working hours decrease and wage rates increase rapidly. These facts explain the especial effort being made by the engineers and contractors to keep down the groundwater level by pumping.

The caissons are sunk in alternate units. The first operation in sinking is to set up the cutting-edge shoe (Fig. 4) built of welded structural steel. Hook bolts are welded to the steel frame of the cutting edge to provide anchorage for the working-chamber concrete. Wood forms are used in building the working chamber and cutting-edge sections. Steel forms (Fig. 4) are used for the remainder of the caisson box. After the working chamber unit has been concreted, the caisson is started downward, excavation at first being done with a clamshell bucket operated by a crawler crane. On top of the working chamber a double height of steel form section is placed, 32 ft. high. This 32-ft. section is concreted, and the caisson is again started downward. From then on the concrete lifts are 16 ft., all built with steel forms. There are about 208 cu.yd. of concrete in a 16-ft. section, and usually a concrete lift is poured every day, the time of pouring averaging about seven hours.

After the box is well started, a wood headframe (Fig. 5) is set on top of the box for open excavation by hand until water is struck and it is necessary to put on air. The headframe covers the entire top of the caisson and is arranged to hoist muck buckets up each of the two material shafts. One double-

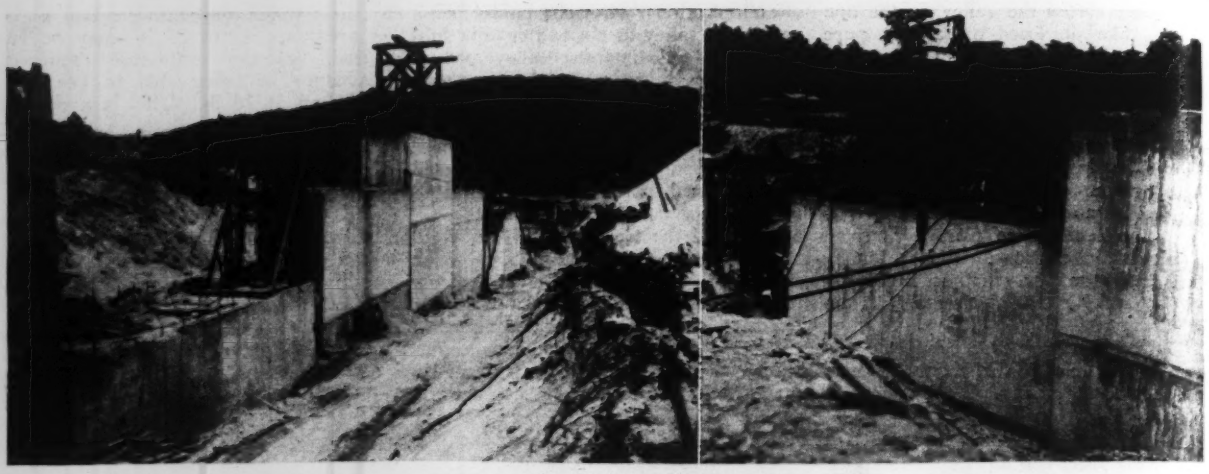


Fig. 5—Caissons finished and in process of sinking, showing timber headframes for both open and compressed-air excavation.

drum electric hoist handles the buckets in both shafts. A tag or dump line is fastened to an outrigger on the tower, and as the bucket is hoisted to the surface this line is snapped onto the bucket, the load being lowered and automatically dumped by the tag line. When water is struck, the headframe and three airlocks (two material locks and one manlock) are placed on each caisson, as shown by Fig. 5. The same double-drum electric-hoist arrangement is used in connection with the airlocks.

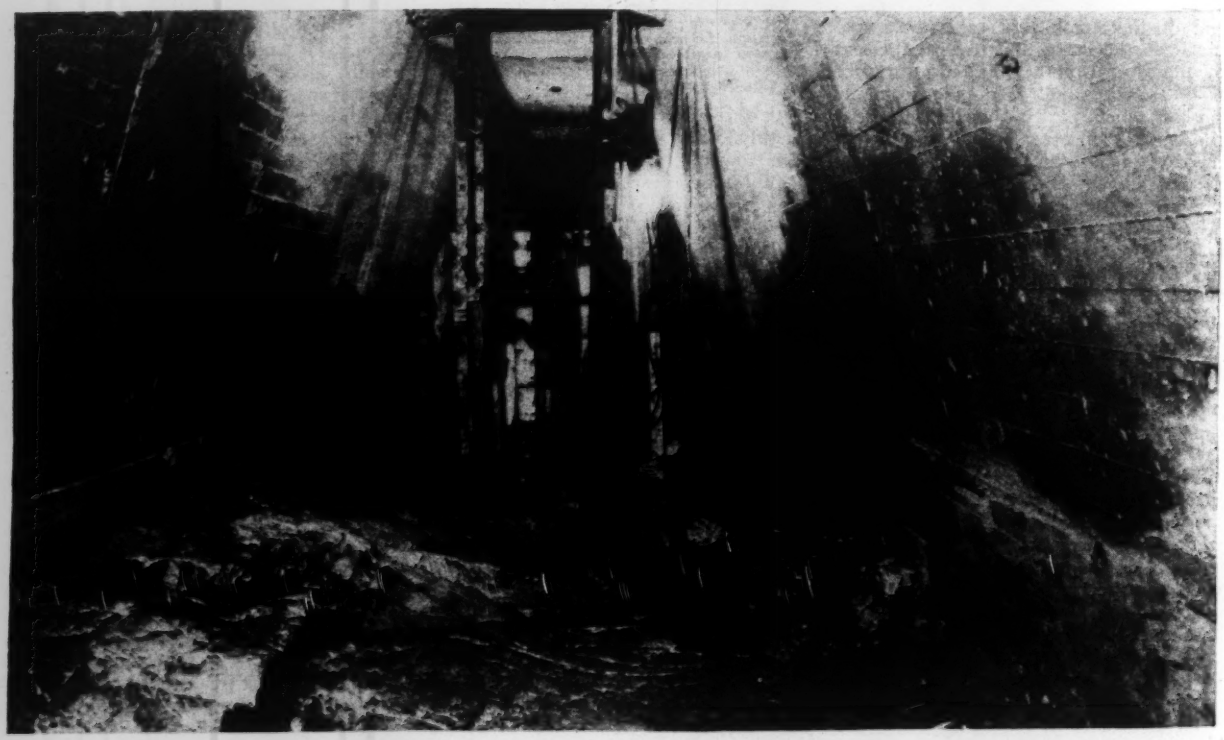
A remarkable record was made on one day in open-work sinking. With eight men in the caisson, it was lowered 13.4 ft. in 7½ hours. This amounts to an average removal of muck per man of 28 cu.yd. for the 7½-hour shift.

After the caisson is landed on rock (Fig. 6) it is usually necessary to underpin the box around most of the cutting edge because of the uneven character of the rock bed. This underpinning is done with concrete and seals off the outside of the working chamber. After the caisson is landed and underpinned, the concrete seal is placed in the working chamber.

As an aid in sinking, the contractor has devised a simple water jet consisting of a pipe nozzle on the end of a high-pressure hose that can be moved around at will under the cutting edge. The most serious difficulty encountered in sinking is caused by large boulders occasionally encountered. It is necessary in most instances to drill and break up these boulders by blasting.

As yet, the contractor has not completed any of the concrete seals in joints between caissons. The contractor is bulkheading off a section of the concrete seal under one of the material locks (Fig. 6). He intends to use this open chamber to cut through to the space between the caissons and then to tunnel through from the joint (under air) and finally raise the shaft between boxes at least above water level, so that the remainder of the excavation and concrete work can be carried on by the workmen in free air.

Fig. 6—Inside of caisson working chamber underpinned to bedrock. Timber bulkhead is being built for tunneling to next caisson and excavating and concreting space between.



Transit-mixed concrete is being furnished at the caisson by the subcontractor, who has a batching plant located about a quarter of a mile from the job. Local sand and gravel are used, material being obtained from a pit about a mile from the job. At the batching plant the subcontractor has erected a screening and washing plant, all aggregate being thoroughly washed and graded. Bulk cement is being used, this cement being hauled from the railroad siding to the batching plant in special covered truck bodies. From the batching plant to the job the concrete is handled and mixed in two 5-yd. transit-mixers. These are the same transit-mixers that the subcontractors used on the Boston-Worcester Pike *(ENR,* June 26, 1933, p. 104).

The compressor plant consists of the following units: three belt-driven, electric-motor, 800-ft., low-air compressors, single stage, and one 300-ft., high-air, belt-drive compressor. The large low-air compressors are driven by 100-hp. induction motors. The job is equipped with an excellent hospital unit containing hospital airlocks and all necessary appliances for treating caisson disease.

Personnel

The work described is being done for the Metropolitan Water Supply Commission of which Frank E. Winsor is chief engineer, N. LeRoy Hammond division engineer in charge of the Quabbin Reservoir project, and Preston N. Putnam resident engineer at the job. The general contractor is the West Construction Co., Boston, Mass., of which C. A. Leighton is chief engineer, A. R. Terwilliger superintendent, and John Drummond job engineer. The subcontractor for general excavation and furnishing transit-mixed concrete is B. Perini & Sons, Inc., Framingham, Mass.

Engineering Features of a Modern Gymnasium

New Payne Whitney Gymnasium at Yale University consists of a tower flanked on either side by auditorium units and houses pools, rowing tanks, basketball courts and numerous work rooms

By E. E. Seelye
Consulting Engineer, New York, N. Y.

BECAUSE of its unprecedented scale and elaborate equipment, the Payne Whitney Gymnasium at Yale presents many interesting and novel structural and mechanical features. As shown in Fig. 2, the structure consists of two large auditorium units flanking a central tower unit. One of these auditorium units contains an exhibition swimming pool surrounded by tiers of steeply banked seats, which will accommodate 2,200 spectators. The other flanking structure contains an amphitheatre surrounding a 95x125-ft. arena floor available for boxing, wrestling, fencing, basketball, indoor tennis, etc., and seats 1,600 spectators. Both of these wings are of bold structural design, their roofs spanning clear spaces of about 127x178 ft. in one instance and 151x184 ft. in the other, and providing a ceiling height of about 45 ft. Between the roof trusses, which are purposely widely spaced, is located a story of squash and handball courts. In addition, provision is made for golf and polo stroke practice, and one of the roofs has a twelve-lap (per mile) running track.

Fig. 1—New Payne Whitney Gymnasium at Yale University is of unusual size and houses a great variety of athletic facilities.

The central tower unit consists of a five-story structure, 186x200 ft., surmounted by a tower 69x91 ft. that contains four additional stories and reaches a total height above the street of 197 ft. This unit houses the work space, practice pool, rowing tank and administrative departments, as well as a three-story trophy hall and a four-story entrance lobby. There is a solarium on the roof.

Structural features

The frame of the building is of structural steel, with a great variety of types of connections. Cinder- and stone-concrete arch floors are used. The building is about 500 ft. long and is divided into three units of about equal lengths by two expansion joints between the tower unit and the two wing structures.

The large trusses over the wings (Fig. 4) are made up of rolled sections of 16-in. minimum depth, plated where required. The gussets, in general, are 1 in. thick, and 1-in.-diameter rivets are used. The trusses were erected with the aid of two steel column struts placed near the bottom-chord splices.

The design and construction of the practice pool in the tower unit (Fig. 5) is of particular interest. This pool, 167 ft. long and 35 ft. wide, is of unprecedented length among pools carried on skeleton steel. Consideration of lower maintenance and longer life led the writer to recommend a reinforced-concrete pool as against a steel pool with concrete lining. With a concrete pool the questions of thermal expansion and of shrinkage of the concrete during setting become important. As far as the thermal expansion is concerned, reliance was placed on a rather low relative temperature range between the tank and the surrounding structure—namely, 30 deg. —which would result in a movement at each end of about $\frac{7}{8}$ in.; it was felt that the elasticity of the structure would absorb this movement. The effect of shrinkage during setting was more serious and was reduced by building the tank in three sections, with $3\frac{1}{2}$-ft. gaps or keyways between. Longitudinal steel was extended into the keyways and was

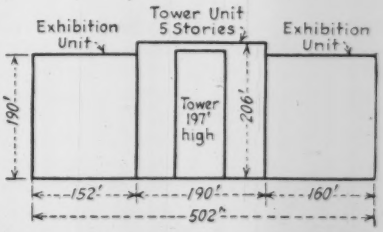


Fig. 2—Plan sketch of Payne Whitney Gymnasium shows how the tower units that house the practice-work facilities are flanked on either side by exhibition units. The unit on the left contains a large swimming pool surrounded by an amphitheatre seating 2,200 persons. The unit at the right provides 1,600 seats around a large arena suitable for basketball and other indoor athletic contests.

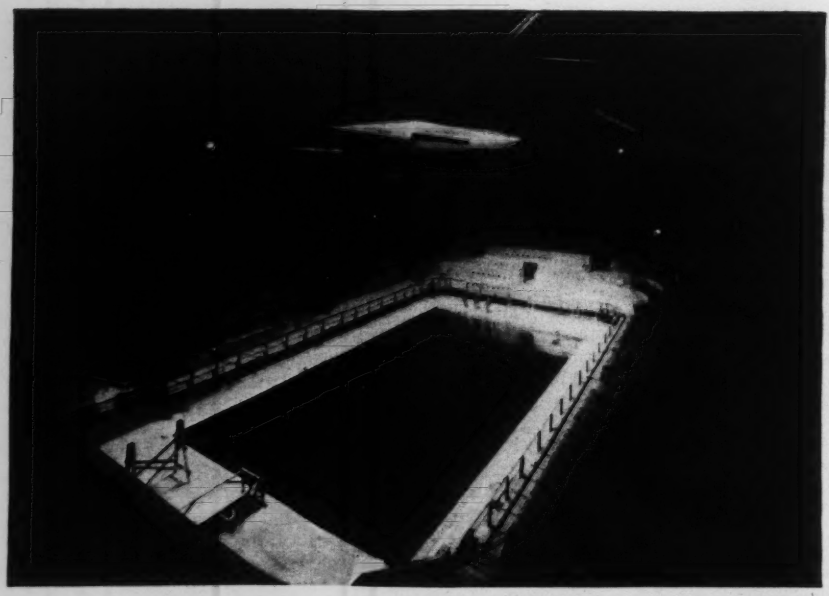


Fig. 3—Swimming meets in the exhibition pool in the new Payne Whitney Gymnasium may be viewed by 2,200 spectators. The pool is 75 ft. long and 42 ft. wide.

lapped adequately with the steel of the adjoining section. The keyways were not concreted until the main sections were fairly well cured, usually when about a month old, so that the only concrete shrinkage that tended to open the construction joints was that which occurred in the keyways themselves. In addition, a high percentage of longitudinal steel (about 0.5 per cent) was used.

Each of the two pools (the exhibition pool and the practice pool) has its individual filtration and purification system. The entire contents of the pools can be circulated by means of the pumps through the filters in about ten hours. As the water is circulated, it is treated with ammonia and chlorine. Before passing through the filters, the water is treated with alum to coagulate the suspended matter, and with soda ash to restore the alkalinity. The water also passes through a heater to bring it to the desired temperature. The inlets and outlets in the pools are generous in size and number and are located so as to give a uniform circulation with a minimum of disturbance. The pools are equipped with vacuum-cleaner outlets, so that the pool walls and bottoms can be cleaned without removing the water.

The rowing tank, located in the tower, which is used for winter training of the crews, consists of a stationary boat past which the water is circulated at a speed varying from 2 to 8 miles per hour. The circulation is accomplished by two motor-driven axial-flow pumps having a total capacity of about 100,000 g.p.m. The motors are push-button-controlled from a panel on the rowing-tank floor, on which is also mounted a tachometer showing the water speed in miles per hour.

The practice swimming pool, 167 ft. long, is equipped with a movable bulkhead for dividing the pool into two pools of varying lengths. This bulkhead is a box girder built of stainless steel 2 ft. wide, 5 ft. deep and 35 ft. long. It is suspended on rollers from rails that extend the full length of the pool, serving also as the scum gutters. A portion of its 5-ton weight is compensated for by air tanks contained within the structure. Inserts are provided at intervals in the side walls of the pool for anchoring the bulkhead.

Fig. 5—The practice pool, nearly 170 ft. long, is built of reinforced concrete poured in three units, with 3½-ft. keyways poured later to reduce shrinkage stresses. A movable stainless-steel bulkhead permits dividing the pool in two sections of any desired length.

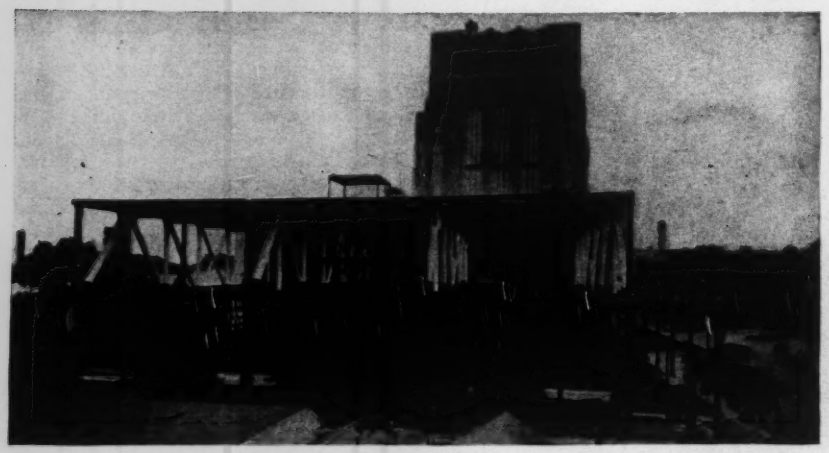


Fig. 4—Long span trusses support the roofs over the exhibition units and also carry a floor of squash and handball courts.

The architect of this structure was the office of John Russel Pope, New York City. The contractor was Marc Eidlitz & Sons. Hollis, French & Co. were the mechanical engineers, and the structural engineers were Elwyn E. Seelye & Co. H. C. Lamb, of the latter firm, acted as supervising engineer. Prof. Theodore Crane, of Yale University, reviewed the design of the reinforced-concrete practice pool.

Termites and Their Threat to Timber Structures

Summary of five-year study of species and wood-destroying habits of prevalent pest, of woods immune to attack and of preservative treatments that prevent attack

By A. A. Brown
Consulting Engineer, Chairman of the Termite Investigation Committee, San Francisco, Calif.

THE SERIOUS CONSEQUENCES of the termite menace have been appreciated on the Pacific Coast for several years prior to the present nation-wide alarm over this insect pest. To study the problem, a cooperative enterprise, the Termite Investigations Committee, San Francisco, was financed by leading industrial corporations, public utilities and lumber associations on the coast. The study has extended over a five-year period and has been national in its scope. The program has been directed by an advisory council from the faculty of the University of California, appointed by the president. About $60,000 has been expended in this work. The final report in book form, of which Prof. C. A. Kofoid is editor-in-chief, is now being printed by the University of California Press. This article is a summary of the highlights from the book. —EDITOR.

THE TERMITE MENACE in the United States, until recently only vaguely appreciated except in some sections, is as serious and as widespread as it is inevitable. With fifty species of the insect native to the country, they are found in destructive and ever-increasing numbers in practically every state. From their original useful function as forest scavengers, breaking down and restoring dead-wood tissue to the soil and air, termites have become a significant economic problem as a result of the artificial accumulation and widespread distribution of their natural food supply in the form of timber in man-made structures. The result has been to facilitate the spread and rapidly increase the number of these insects. To date, there have been no corresponding control measures because the habits and activities of termites have been so little understood by the construction industry and the general public.

The first impression to be corrected is the common idea that the observation of termite work for the first time in a community indicates an invasion. For example, the New York press, in commenting on termite activity in that city, recently said, "Termites multiply rapidly, work slowly but thoroughly. New York's invasion came three years ago; whence, no one knows. Now every sectoin of the metropolitan area is infested." The committee has received letters from points well distributed throughout the United States appealing for help to meet "the invasion of these pests." On the subject of termite invasion, Prof. S. F. Light, University of California, says:

"It cannot be too strongly emphasized that all of the termites doing extensive damage in the United States and, indeed, all except one, or possibly two, of the 54 species known to occur in the United States, are native species. We are not facing, therefore, any sudden invasion of new forms, as many have imagined, but simply an adjustment with species present for millions of years before man entered upon the scene. The two supposedly introduced species have very restricted ranges within the United States. *Reticulitermes lucifugus*, the European subterranean termite, is found only in the vicinity of Forest Hills, Mass., and *Cryptotermes brevis*, the common powder-post termite, of wide distribution in the West Indies, Mexico, and Central and South America, has been found in four localities in southern Florida and in one locality in extreme southern Louisiana."

The termite problem arises out of man's attempts to change the ordinary processes of nature by preserving for his own use, over considerable periods of time, wood and its products, which it has been the immemorial function of the termites and associated organisms to break down and return to the soil and the atmosphere.

Characteristics and types

Termites are primitive insects related to cockroaches. Unlike these scavengers, the termites live a secreted life, feed primarily on cellulose, and are organized in colonies, diversified into castes (Fig. 1) differing in structure and function. This social organization prolongs their period of larval immaturity, increases their destructive potentialities, and has accelerated the evolution of highly specialized instincts. These factors combine to raise the termites to a high level of efficiency among insects in general. They naturally extend and accelerate their work as destroyers of wood and cellulose in tropical and temperate regions.

Termites are commonly, but erroneously, called "white ants." Not all species and castes of termites are white, and no termite is a true ant. While it is true that the vast majority of the individuals of the colonies of the termites are white (Fig. 2), these are not usually visible unless dug out of their burrows in wood or earth. Other individuals of the same species, the winged forms called "alates," have dark, even black, bodies and usually dark wings (Fig. 1*a*). These

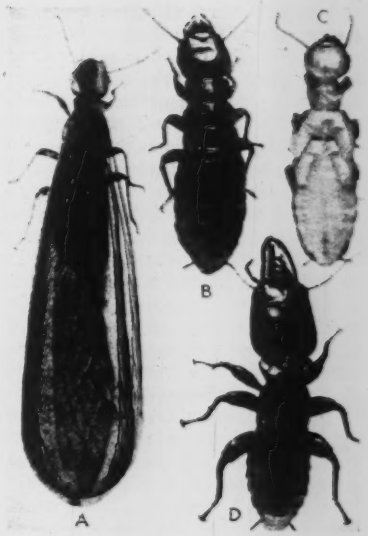


Fig. 1—Members of a termite colony: *(a)* winged reproductive-colonizing male or female; *(b)* late-growth stage of nymph, which will become soldier; *(c)* late-growth stage of nymph, which will become winged reproductive; and *(d)* soldier.

are to be seen flying or emerging from wooden structures or the earth for a few hours only at the swarming season. The term "white ant" should therefore be abandoned, since it leads to serious misconceptions as to the identity of the insects properly named *termites*, and confuses them with others having very different habits and requiring entirely different methods of control.

Termites fall into two major habit types: wood-dwelling termites and earth-dwelling termites. Wood-dwelling termite colonies are found in the wood itself. The majority of this type attacks only dry sound wood; they are known as dry-wood termites and are confined to the coastal and southern states. Others, known as damp-wood termites, are found in damp and decaying wood; they are largely confined to the Pacific Coast. Earth-dwelling ter-

Fig. 2—Group of damp-wood termites at natural size showing relative size of caste individuals.

mites are of several different types, and the group that is the most economically important is known as subterranean termites. They live in the earth and feed upon wood placed in or on the ground. Occasionally they attack wood placed away from ground contact by building tubes or covered runways to it from their galleries in the ground. They are widespread and responsible for by far the greater part of the damage done.

The life habits of termites render impracticable the control methods used for other insects, such as: (1) biological control by the use of enemies; (2) poison bait, as in the control of common house-ants; (3) the use of traps or the widespread distribution of contact or food poisons, as in the spraying of fruit trees for the codling moth; (4) the poisoning of mosquito breeding-grounds, and other means.

The food of termites is primarily cellulose and is usually taken from the wood within which their burrows are made. The termite itself cannot use the wood as food, but depends upon a seething mass of one-celled animals belonging to the flagellated protozoa which occupy the intestine and make the cellulose in the wood available. If the protozoa that normally inhabit the gut of the termite are killed by one of several methods which do not harm the termite, the latter will starve to death.

Termites and wood-boring beetles accomplish a unique function among insects in the scheme of nature by their assistance in returning wood to the air and soil, from whose chemical constituents it took its origin. They thus occupy a unique place in the natural cycle of water and carbon dioxide, playing a prominent part in the turnover of the more resistant product of photosynthesis, namely cellulose, especially in the tropics. The proteins, sugars, starches and oils produced by plants are subject to ready disintegration, whereas cellulose, by reason of its physical and chemical powers of resistance, is less subject to bacterial action and to digestion. As a result, cellulose, which is so large an element of higher plant (or woody plant) growth, is the basis of the evolution of termites.

Fig. 3—Example of termite work with complete destruction of the timber, leaving only the thin shell that often effectively conceals the damage.

Associated with termites in this biological scheme of returning to the soil and water the constituents of the cellulose created by photosynthesis, are the fungi which grow in wood, some of which are responsible for its decay. The conditions favorable for termites are also favorable for fungi, and hence these two organisms are very commonly found in close association. Spores and hyphae occur on the bodies of termites, and cultures from their exterior, their digestive tract and their pellets almost universally yield fungi.

Spread by man

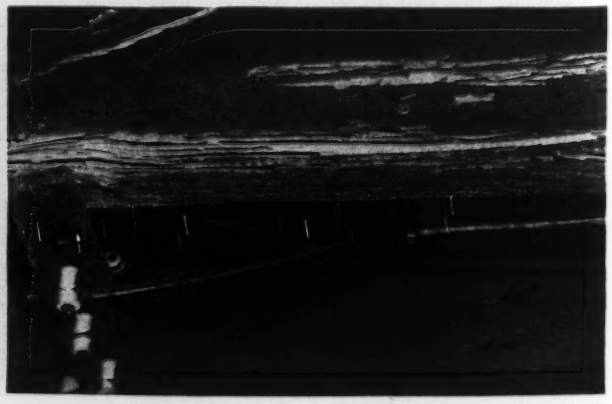
Man's relation to the termites' cellulose cycle is important by making available to the termite large stores of food. He masses wood in buildings in cities and villages and spaces it conveniently along his lines of transportation, as poles and fence posts. These structures foster local concentration of infestation, facilitate the spread of termites into fresh areas and assist in the extension of infestations from the existing natural reservoirs of the different species.

Fig. 4—Earth-dwelling termites build cone of earth to reach wood joists under residence (left). Resulting damage (right) exposed by opening up timber, although only external evidence was the small holes indicated by arrows.

Man buries timbers in soil already inhabited by termites that have been accustomed to find their natural food supply in roots and stumps of forest and field. He places his houses, barns and other structures in contact with the earth, thus favoring infestation by subterranean and damp-wood termites. He builds other structures with convenient crevices in roofs and walls, into which dry-wood termites may find entrance and establish colonies. Man has provided extensive and convenient groups of comfortably heated homes for these wood-eating insects. The social organization of the human species thus supplements and favors the maintenance and spread of these social insects by providing food and shelter grouped and distributed most favorably for the organized life of the termite.

In another particular man's activities favor the life of termites. The wood made available for termites through construction operations is not, as a rule, that dying on the stump and thus slowly brought to the verge of decay, but the tree killed in the full flush of its activity and rich in the stored products of photosynthesis, containing more proteins and other food elements desirable in the diet of termites. These food products are variously distributed in the trees according to season of year and other climatic factors, and are also differentially distributed in the several parts of the trunk. In general, sapwood contains a liberal proportion of these products, and for this reason, as well as because of the fact that it has a smaller amount of the more resistant lignin, it is more attractive to termites than the rest of the trunk.

The construction industry, therefore, has made available to the termite an unlimited food supply under conditions favoring a rapid colonization by these insects. Termites multiply by geometric progression and in time, can be expected to move in and occupy the available food supply. Termites have been doing this very thing and have so extended their activities that their presence has finally been recognized, and each discovery is designated as an invasion. Economical and practical methods of



preventing termite attack upon wood and its products must be based upon a knowledge of the habits and life histories of the particular types of termites causing the damage, and in some instances even of the particular species.

The earthquake in southern California on March 10, 1933, emphasized the fact, according to the report of the coroner of Los Angeles County and others, that wood-frame buildings, whether finished with wood or stucco, suffered relatively minor damage, and that a considerable portion of this damage was through the collapse of underpinning and structural members. The greatest damage was reported to be in sections where the greatest number of residences infested with termites were found. This revelation by the impartial and searching earthquake test confirms the fact that wood is eminently adapted for meeting earthquake stresses in residential structures, and that the prevention of termite infestation is essential in maintaining the protection that the use of wood affords.

Termite control

The main objective of the committee's five-year research program has been to discover the most feasible method of conserving for man's use the products of our forests. The solution of the problem lies in making undesirable or unavailable to termites the cellulose-containing materials that it is desirable to conserve.

Tests show certain species of wood to be naturally more resistant to termite attack than others. The sapwood of practically all species of trees is palatable to termites, and the heartwood of most species is also palatable to a less and varying degree. The heartwood of certain species, such as cedar, cypress and redwood, is less palatable than that of most other species. Heartwood of these species is usually not attacked if other wood is available, and is referred to as less palatable wood.

In the heartwood of these less palatable species there is a direct parallelism between the restriction of damage by both termite and fungus and the amount of soluble extractive. Hawley, Fleck, and Richards (1924)* subjected fungus hot-water soluble extractives from various woods and report that, "The relative resistance to decay of the several woods examined can be largely explained by the toxicity of their extractives." They also report, "It is a noticeable fact that, as far as their chemical composition have been determined, woods that are durable under actual service conditions contain extractives of a peculiar kind in large amounts. The non-durable woods, it is also to be noted, are generally low in such extractives." Result of the committee experiments in-

Fig. 5—Characteristic appearance of pole damaged by subterranean termites, with secondary destruction by decay at the groundline.

dicate that heartwood containing high concentrations of natural preservatives is less palatable to termites, in general, than wood of the same species that contains low or medium quantities of such preservatives.

It has also been noted that some very resinous pieces of heartwood from a species of wood that is usually palatable are less palatable to termites than heartwood from the same species that is low in resin content. The following indicates that such woods react similarly to decay. "The natural preservatives stored in the heartwood may be present in larger amounts in some trees than in others of the same species. Wide differences in this respect may be found even in different parts of a single log, with resulting differences in decay resistance. In the pines and Douglas fir occasional pieces are very resinous or pitchy. Wood thus saturated with pitch or resin is exceptionally resistant to decay and gives very long life in contact with the ground or in other places where conditions favor decay."†

The studies of the committee have resulted in establishing a standardized biological method for the determination of relative termite resistivity of natural and chemically treated woods. Its application to natural woods gives coherent and consistent results of fair uniformity with contiguous samples from the same board. The resistivity varies within a species and among different species, as is notably the case in redwood that was tested the most extensively. The variations in termite resistivity show a fairly direct correlation with the amount of the extractive.

The hot-water soluble extractive of redwood shows wide variations in amount, which are inversely correlated with the volume of excavations of termites and directly correlated with the death of protozoa in the termite gut. Samples of redwood with highest extractive have least excavation. Samples with extractive over about 12 per cent by weight are lethal to the protozoa of the termite gut and result in the death of from 43 to 86 per cent of the colony in 60 days. Presumably redwood retaining not less than 12 per cent of extractive is adequately termite-resistant when and so long as it contains this amount of the hot-water soluble extractive. These tests suggest the advisability, when purchasing naturally resistant woods, of doing so, as in the case of treated wood, by specification and laboratory test to insure the proper percentage of hot-water extractives.

Tests were made to determine the toxic value of wood preservatives in various concentrations and amounts. Service records show that wood treated with toxic chemicals other than coal-tar creosote have proved satisfactory for the length of time they have been used, but in few cases do such service records extend over a period equal to the life to be expected of ordinary structures. Wood pressure-treated with coal-tar creosote is known from service records to have a satisfactory use-life.

Coal-tar creosote in its crude state is oily, heavy and black, and has a strong odor of peat smoke. This odor is most objectionable in the home. The black color of coal-tar creosote renders its impracticable for use where color painting is required. It was with the object of eliminating these objections from the crude creosote oil that the Reilly Tar and Chemical Corporation, Indianapolis, in cooperation with the committee, undertook a prolonged research study. This investigation finally resulted in an entirely new product "Reilly Transparent Penetrating Creosote," which is a highly refined, blended coal-tar creosote oil from which have been removed those substances that impart color and odor and impede penetration in the wood. Termites did not feed upon blocks that were pressure-treated with 7.1 lb. per cu.ft. of a 12 or 25 per cent solution by weight.

Committee recommendations

The termite investigations committee has prepared general recommendations for the prevention of damaged by termites, as follows:

(*a*) Construction methods for new work and for the repair of existing structures should keep all untreated wood away from contact with the ground.

(*b*) If the most complete protection from damage by termites is required, and if feasible, all wood that is placed in the ground or in contact with the ground should be impregnated according to standard specifications with chemical preservatives known to give protection.

(*c*) Wherever termite damage to wood not in contact with the ground is

*Hawley, L. F., Fleck, L. C., and Richards, C. A., 1924. The relation between durability and chemical composition in wood, "Industrial and Eng. Chemistry," 16:699.

†Hunt, G. M. Factors which influence the decay of untreated wood in service. 1928b. U.S. Dept. Agr., Forest Service, Forest Products Laboratory, R68:1-7.

to be prevented, and when this cannot be done by methods of construction, and if feasible, wood should be used that has been impregnated according to standard specifications with chemical preservatives known to give protection. This applies to attack by dry-wood termites, as well as to attacks by subterranean termites through covered runways over foundations.

(*d*) Where the use-life of a structure is relatively short, or where the most complete protection by pressure impregnation is not feasible, and where a measure of protection greater than that afforded by untreated woods of most species is desired, the committee recommends the use of sound, seasoned heartwood of species known to be relatively unpalatable to termites. The protection secured increases with the amount of extractive present in the wood, and the duration of this protection depends upon the retention of a toxic amount of the extractive in the wood. The loss of extractive will depend upon the degree of exposure to the elements and to soil moisture.

(*e*) The dipping, brushing or spraying with chemicals toxic or repellent to termites gives some protection, although such methods are not included in the standard specifications. The degree and duration of protection attained depend upon the initial toxicity of the substance, its permanence in the wood, its concentration in the wood, and the integrity and thickness of the protecting coat.

The committee does not recommend that arsenical preservatives be used in the treatment of wood, wallboard, building paper or other material used in dwellings or buildings occupied by man, or in or on soil underneath such structures as a treatment against termites.

Improved Internal Drainage for Hydraulic-Fill Dams

Modifications of current methods of constructing hydraulic-fill and semi-hydraulic-fill dams proposed in order to improve the internal drainage by creating definite channels of permeable material

By E. McD. Moore
Chapin, S. C.

FROM a considerable experience in the construction of a few earth dams and from knowledge of trouble that has resulted from a lack of free internal drainage in others Mr. Moore outlines in the following comment the way in which the ideal in hydraulic-fill and semi-hydraulic-fill earth-dam construction might be more nearly approached than it has in the past. The article is not intended to cover the design of such dams in full; its purpose simply is to point the way toward eliminating one of the chief problems of those who undertake to build dams by the hydraulic method.
—EDITOR.

THE IDEAL DAM of the core type is described in this article, and the hydraulic-fill and semi-hydraulic-fill types are compared with it. The chief difference between the ideal type and the two other types seems to be in the drainage characteristics of their outer parts. These characteristics depend entirely upon the character of the borrowpit material, which in turn also is the chief factor in determining whether a dam should be of the hydraulic-fill or of the semi-hydraulic-fill type. As a logical means of approaching the ideal, a method of installing a drainage system during the construction of a dam is given, which, by enabling the surplus water to escape, hastens the consolidation of the core, prevents the outer parts from becoming water-soaked, prevents static pressures from being built up in these parts and enables them to function fully as supports to the core.

For dams not subject to overflow, the ideal type probably would be one designed with a clay core, contained in and stabilized by masses of granular material whose particles range in size from fine sands adjoining the core to rocks up to several cubic feet in volume as the outsides of the dam are approached.

The clay core of this dam would afford watertightness, and it would maintain its watertightness under considerable distortion. On this account it would seem to be a type of construction most resistant to earthquake movement. The fine sands adjoining the core would afford free drainage to the water issued by the consolidation of the core with the minimum amount of back pressure, and at the same time they would prevent the escape of any of the core material itself. In a number of tests made by the writer he has noticed that when samples of a clay mud were placed in a tube with sand strainers some 3 or 4 in. deep, both above and below the sample, the penetration of the clay mud-ors into the sands under pressures up to 140 lb. per sq.in. was less than ¼ in.

The larger-sized materials in the outer parts of the dam stabilize the entire structure. These parts are at all times free-draining, and their full weight resists any movement of the core.

Ideal not obtainable

The cost of securing and placing the materials for the ideal dam is generally prohibitive, but as a near approach to the ideal type both the hydraulic-fill and the semi-hydraulic-fill types are used. In these the functions of the several parts are the same, with the exception that whether or not the outer parts are self-draining depends, in the hydraulic-fill dam, on the character of the borrowpit material and how completely the fines are removed from it, and in the semi-hydraulic-fill dam it depends entirely upon the character of the borrowpit material.

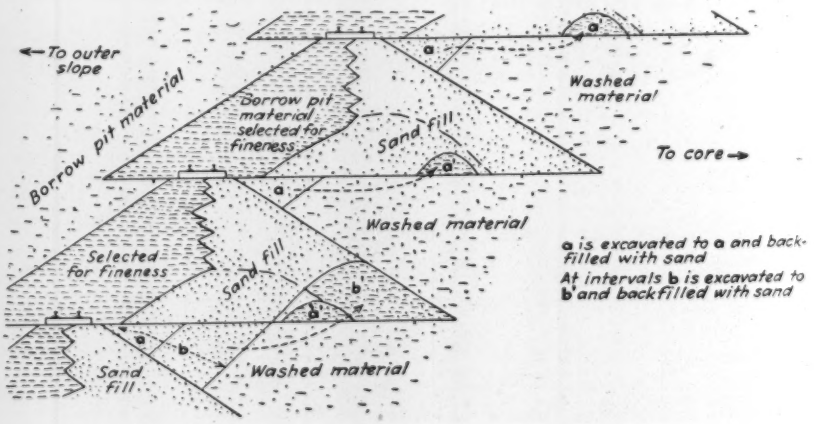
There are three general classes of borrowpit material:

First, granular materials that are free-draining, as sand and gravel.

Second, clay and clayey materials that may contain considerable quantities of granular material but not enough to bridge and prevent the material from consolidating and squeezing out surplus water. Residual soils are generally of this class.

Third, clayey granular materials that contain such large amounts of clayey material that this latter prevents free drainage and the granular material pre-

Method of making trestle fills to improve interior drainage. Trestles are omitted and out-drains are not shown.



vents any consolidation and squeezing out of surplus water. Silts and partly decomposed granites may be of this class.

It would seem that the proportion of the borrowpit material that must be washed to secure the fines needed for the core determines the type of dam. If more than two-thirds of the material must be washed, the dam would probably be of the hydraulic-fill type, while if less than two-thirds has to be so treated, the dam would probably be of the semi-hydraulic-fill type. Hydraulic-fill dams would be made from the first of the three major classes of materials listed above and sometimes from the third class, while semi-hydraulic-fill dams would be made from the second class of materials and sometimes from the third.

The drainage characteristics of both the second and the third classes of materials are such that the use of either of these materials in the outer parts of a dam calls for some method of preventing the water used during the construction period from ever entering those parts. This can be accomplished by drains in the beach areas extending out through the toes, with an area of material selected for impermeability placed just outside the beach area.

The amount of washing should be no more than enough to secure the desired amount of fines. The farther in the washing goes and the smaller the amount of material that must be washed, the better. All the material that is washed must be *thoroughly* washed, for the more nearly the fines are removed from it the more nearly free-draining it becomes. The amount of material that must be washed determines the width of the pool, and no material should be washed outside the outer limits of the pool.

Construction procedure

If construction trestles are used, they should be placed just outside the outer limits of the pool on each side. Then the first materials that are dumped from each trestle are, on the pool side, a free-draining bank sand and, on the outside, the most impermeable type of borrowpit material obtainable. The two sides should be brought up together so that the completed fill will be approximately half sand and half selected material. The selected material will function better if it can be wetted down as it is placed.

At intervals of some 200 or 300 ft. along these longitudinal fills and tied into the sand part of them, sand fills should be built extending out beyond the upstream toe of the upstream fill and beyond the downstream toe of the downstream fill. As the second and all subsequent trestle lifts extend beyond the bottom trestle, the same system of fills should extend with them, until they extend finally for the full length of the dam.

In this design the second and upper trestle lifts are placed over and to the inside of the lower lift, if washing at the lower level has to be carried up so that they can move in. This trestle arrangement has two considerable construction advantages: First, construction of an upper trestle can begin as soon as track has been thrown out some 10 ft. instead of waiting until track can be thrown in some 70 ft. as is the case when track is thrown in on a $2\frac{1}{2}$:1 downstream slope; and, second, when washing is still being done on the lower level the badly skewed crossings over the lower track are avoided.

Drainage requirements

Whether or not the sand fills should be carried on up with the upper trestles depends entirely upon the drainage characteristic of the beach material. If that material is free-draining, there is no need of carrying the sand fills one above the other. But if that material is not free-draining, the sand fills should be carried up to the full height of the washing.

If the sand fills in the upper levels are omitted, all of the first material dumped on each new trestle level should be of the most impermeable material available, preferably wetted down. The importance of this material in this place cannot be overemphasized. During the construction period it acts as a curtain between the gorged beach area and the outer parts of the dam. Made of a clay or clayey material, it will immediately begin consolidation as it is dampened and should prevent the outer parts from becoming charged with water during construction and the downstream outer part from ever becoming charged.

Form of drains

The quantity of water carried through the out-drains at any time is small, but they should be not less than some 8 to 10 ft. high, so that they may be large enough to work under the abuse that they will receive during construction.

The accompanying sketch shows a partial section of a dam where the sand fills are carried on up above the first trestle lift. The washed material lies to the right; adjoining it are the sand fills backed by the material selected for its impermeability, and, at the extreme left, the whole borrowpit material. The material at *a*, which after it had been dumped and washed over probably will have much the same characteristics as the whole material, should be moved as indicated, so that the sand beneath it is exposed and the new fill tied into it.

This method of draining a dam has not been tried, to the writer's knowledge, but since this article was prepared a parallel has been called to his attention. It is found in a dam where the silty sand in the riverbed and adjoining flats had been removed from the middle third during construction and dumped in the upstream and downstream thirds. After the dam had been completed, a number of well casings were driven in the downstream slope, and they are read regularly to observe the line of saturation in the outer parts. The holes in the material overlaying the free-draining material show less water than any other holes in the entire dam, though they are in the area of maximum head.

Flooded Waterworks Requires Emergency Sanitation Measures

Pumping station put out of service and reservoir filled with river water—Emergency chlorination measures prevent outbreak of waterborne illness

PROMPT ACTIVITY by the engineering staff of the Illinois Department of Health in instituting emergency measures during the flooding of the Streater, Ill., waterworks plant in the middle of May was instrumental in averting what might have been a disastrous waterborne epidemic. When the Vermilion River overflowed, the plant's boiler house and pumping station were flooded out and the flood-water poured into the clear-water basin and put the chlorination equipment out of service. Emergency supplies of water were brought into the city in tank cars, chlorinated by the state health department staff, and emergency chlorination equipment was employed when the pumping facilities could again be put back into service. No cases of waterborne illness occurred.

A rain of 3.3 in. within a few hours on May 11 caused a sudden flood stage of the Vermilion River, which serves as the source of the public water supplies of Pontiac and Streator, Ill. The Pontiac waterworks is on a high bank, and the flood did not interfere with normal operation. The Streator waterworks plant, however, is located on river-bottom land, and a concrete wall had been built around the pumping station and boiler house a number of years ago for flood protection. A brick wall had also been built around the clear-water basin, a little higher than the walls of that basin.

When the flood occurred, effort was

Fig. 1—Floodwaters from the Vermilion River overtopped a protecting wall and poured into the clear-water reservoir. The two small buildings in the foreground contain the plant's chlorination equipment, which was put out of service.

made to use planks and sand bags to keep the floodwaters from overtopping the wall protecting the boiler house and pumping station, but the wall had not been designed to stand such pressure and collapsed, permitting rapid flooding and the putting out of service of the boilers, pumps and auxiliary equipment. The polluted river water overtopped the protecting wall around the clear-water basin and permitted the river water to pour into the basin and put the chlorination equipment entirely out of service. The flood-protection walls broke at the waterworks about 1 p.m. on May 11, and the entire city was out of water within an hour. There was no elevated storage.

The state health department was notified of the situation at 9 o'clock of that evening, and emergency chlorination and control equipment was immediately loaded in automobiles by the division of sanitary engineering. Two state sanitary engineers with the equipment were at Streator early the following morning. They found that the floodwaters could not be removed from the boiler room and pump pits until the level had receded from around the building. The pumps were cleaned of mud and grit and placed back in service about 4 a.m. on May 14. Thus no water had been pumped into the Streator distribution system for about three days.

In the meantime, to make safe drinking water available to the 14,728 residents of Streator, tank cars of water were hauled in and chlorinated by the state sanitary engineers, and a few scattered private and semi-public wells that still existed in the city were chlorinated and placarded. Water carried from such tank cars and wells for use at lavatories and for washing dishes was saved after such usage and used for flushing toilets.

Fig. 2—The wall protecting the pumping station and boiler house gave way under the water pressure, and boilers and pumping equipment were out of service for three days.

Some people moved their families to relatives or friends in other cities or went to hotels in other cities.

When pumping into the distribution system was resumed, the state sanitary engineers set up one of the state's emergency chlorinators on top of the clear-water basin and continued to chlorinate the public water supply in that manner for two days. In addition, the water in the basin was heavily dosed with hypo-chlorite before the pumps were started. The water company's two chlorinators could not be placed back into service without additional parts and service from the manufacturers, which became available two days later. In the meantime, the entire public water supply was chlorinated as it was pumped into the distribution system with the emergency chlorinator.

During the period that the pumping station was out of service negative pressures had existed in the distribution system, which permitted the drawing in of contamination through any leaky mains and back-siphoning of contaminated water from defective plumbing installations. Therefore, the distribution system was thoroughly flushed by opening fire hydrants before the consumers were advised that the water was safe without boiling. Also, the public was notified through the local newspaper that all taps in buildings should be opened and flushed in order to draw through them the chlorinated water and displace or sterilize any contaminated water that may have been trapped in the service piping during the period the water was shut off. During the flushing of the distribution system, service connections and house plumbing a high residual chlorine was maintained.

During the emergency and directly following it there was not a single case of illness reported that could be attributed to a polluted water supply.

Czechoslovakia to Build Public Works for Unemployed

In order to provide immediate relief for unemployed persons in Czechoslovakia, whose numbers have been proving burdensome to the state budget, the government has just decided not to wait for the final yield of the new internal capital investment loan and has released from the fund already available an amount of 106,114,000 crowns, or about $3,183,400, to cover public-utility construction plans that can be started without delay. The plans include highway and railway construction, buildings and equipment for government forests and estates; public schools, water mains, sewerage systems and similar projects. It was stipulated that contractors for such works must guarantee to use as few mechanical devices as possible in order that a maximum number of persons may be provided with employment.

Tests of Aggregate Interlock at Joints and Cracks

Michigan concrete pavements under load tests indicate general effectiveness of aggregate interlock in transferring shear and value of reinforcement in increasing the bond of cracks and joints

By A. C. Benkelman
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WHEN the pavement dummy joint was first introduced, there were many highway engineers who viewed its use with alarm. They contended that although joints of this type might successfully control or localize cracking, their ability to transmit load from one slab to another was open to serious question.

The Michigan state highway specifications permit the use of either the dummy or the deformed-plate center joint in concrete pavements. Surveys of the older projects containing the dummy joint indicate conclusively that it has served to control longitudinal cracking and moreover, as far as can be ascertained by visual examination, it has functioned satisfactorily as a load transfer medium.

In order, however, definitely to establish its value with respect to load transfer, a series of loading tests was made. In planning these tests it was appreciated that if two slabs separated by a dummy joint were held tightly in contact, either by tiebars or reinforcement, the aggregate interlock at the line of fracture would serve to transmit load so long as the shearing resistance of the roughened edges was not exceeded. Likewise, it was recognized that the tendency of such edges to shear off or wear smooth under repetitions of load would be greatly accentuated if the joints were opened to an appreciable extent by any external force. It was decided, therefore, to apply heavy loads alternately to either side of tightly closed and open joints and measure the relative effect produced in both the adjacent slabs.

Considerable trouble was experienced in locating slabs where any appreciable opening of the center joints existed. This was particularly true of pavements containing dummy joints, the maximum age of which was three years. As a result, the information obtained from the first summer's work (1931) did not determine conclusively the load-transferring ability of this type of joint.

Plans were accordingly laid to continue the investigation in 1932 and to load transverse cracks in plain and reinforced pavement where a better opportunity would be afforded to study the effect of opening and closing upon load transfer. Fundamentally, cracks in concrete pavements have all the characteristics of dummy joints, and they should exhibit the same load-transfer characteristics. The primary difference rests in the depth of cross-sectional area of aggregate interlock. In case of cracks, the entire cross-section of the slab constitutes this contact area, whereas in the case of dummy joints the groove which the joint filler occupies serves to reduce the depth or area of contact by approximately 33 per cent. Nevertheless it was felt that considerable information could be secured as to the effectiveness of the so-called aggregate interlock to transmit load by subjecting cracks to the same test previously applied to the longitudinal joints.

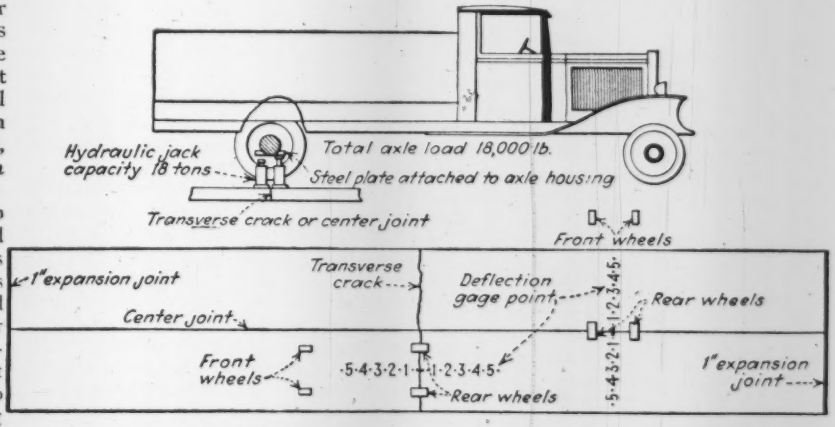


Fig. 1—Method of applying load to pavement joints and cracks; also locations of instrument gage points.

A series of 22 transverse cracks, 8 of which were in plain pavement, 7 in welded-mesh and 7 in bar-mat reinforced pavement, were subjected to test. The pavement in which these cracks existed was four years old and of the conventional thickened-edge design. Loads were applied on both sides of the cracks, first during the summer months when they were well closed; later in the fall when the concrete was in a contracted state and the tendency existed for such cracks to open, and finally in December before freezing weather set in. The results derived from these tests are considered conclusive in character. They will be discussed in detail later in this report.

Loading method described

The method of loading is shown graphically in Fig. 1. A 7-ton truck was loaded so that the total weight on the rear axle was 18,000 lb. The rear wheels of the truck were centered over a joint or crack, as shown, and two hydraulic jacks, one on each side of the separation, were inserted beneath a steel plate bolted to the bottom of the differential housing. By raising one of the jacks the entire rear-axle load was applied on one side of the separation. To apply the load alternately to either slab, it was then necessary merely to raise and lower the other jack, an operation that could be easily and quickly performed. Fig. 1 also shows truck-position and instrument-gage points for the center joint and crack-loading tests.

With this method of loading, it was fairly simple to investigate the effect of either a single application of load or the effect of alternate applications to either side of joints or cracks. In most of the tests only the relative deflection induced by the load in the slabs on either side of the separation was measured. The attempt was made in the center-joint tests to measure deformations with the Berry strain gage, shown in Fig. 2, but the results were decidedly erratic and its use was abandoned in later tests in favor of the clinometer or deflectometer, also shown in Fig. 2. Two of the latter instruments were constructed from drawings furnished the department by the Bureau of Public Roads. It consists essentially of a horizontal bar in which a level bulb is inserted that can be raised or lowered to a level position by a vertical adjusting screw on the one end. The extent of vertical movement or deflection over the gage length of 20 in. is read on the Ames dial shown. This instrument proved exceptionally easy to use and extremely accurate. As shown in Fig.

TABLE I—LONGITUDINAL JOINT TESTS
Slab-Deflection Values and Percentages of Load Transferred
(9-7-9-in. 20-ft. Pavement)

Location Reference Number	Age Pavement, Years	Type of Longitudinal Joint	Visible Condition of Joint	Tiebar Spacing, In.	A—Initial Load						B—After 50 Applications (Each Side Joint)					
					Load 1 (Right Side Joint)			Load 2 (Left Side Joint)			Load 3 (Right Side Joint)			Load 4 (Left Side Joint)		
					Deflection (In.)		Per Cent Load Transferred	Deflection (In.)		Per Cent Load Transferred	Deflection (In.)		Per Cent Load Transferred	Deflection (In.)		Per Cent Load Transferred
					Loaded Side	Unloaded Side		Loaded Side	Unloaded Side		Loaded Side	Unloaded Side		Loaded Side	Unloaded Side	
16-1 o	7	Deformed metal plate	Open*	60	.0176	.0125	42	.0210	.0054	20	.0220	.0103	32	.0187	.0076	29
16-2 o	7	Deformed metal plate	Open*	60	.0226	.0133	37	.0245	.0143	37	.0200	.0083	29	.0220	.0080	27
16-3 o	7	Deformed metal plate	Open*	60	.0159	.0082	34	.0170	.0045	21	.0170	.0055	24	.0152	.0050	25
78-1 o	7	Deformed metal plate	Open*	60	.0368	.0228	38	.0465	.0147	24	.0365	.0185	34	.0398	.0100	20
Average	7	Deformed metal plate	Open*	60	.0232	.0142	38	.0272	.0097	26	.0239	.0107	31	.0239	.0077	24
16-1 c	7	Deformed metal plate	Closed	60	.0195	.0183	48	.0227	.0163	42	.0153	.0157	51	.0175	.0146	45
39-1 c	7	Deformed metal plate	Closed	60	.0112	.0105	48	.0144	.0103	42	.0095	.0112	54	.0111	.0083	43
78-1 c	7	Deformed metal plate	Closed	60	.0167	.0176	51	.0218	.0181	45	.0175	.0152	47	.0193	.0138	42
127-1 c	7	Deformed metal plate	Closed	60	.0167	.0170	50	.0177	.0169	49	.0163	.0158	49	.0170	.0170	50
Average	7	Deformed metal plate	Closed	60	.0160	.0159	50	.0192	.0154	45	.0147	.0145	50	.0162	.0134	45
14-1 o	3	Dummy	Open*	30	.0222	.0150	40	.0264	.0111	30	.0236	.0170	42	.0310	.0110	26
14-1 c	3	Dummy	Closed	30	.0101	.0097	49	.0102	.0097	49	.0086	.0078	48	.0087	.0074	46
78-2 c	3	Dummy	Closed	20	.0119	.0119	50	.0170	.0122	42	.0135	.0089	40	.0140	.0122	47
Average	3	Dummy	Closed	..	.0110	.0108	50	.0136	.0110	45	.0111	.0084	43	.0114	.0098	46
		Grand Average—Open Joints		.....	.0230	.0144	38	.0271	.0100	27	.0238	.0119	33	.0253	.0083	25
		Grand Average—Closed Joints		.....	.0144	.0142	50	.0173	.0139	45	.0135	.0124	48	.0146	.0122	46

* 1/16 to 2/16 in. opening at surface

1, the bearing plugs were set in a line, on 20-in. centers, perpendicular to the joint or crack at the point where the load was applied. As the base of the hydraulic jack was 5 in. in diameter, it was necessary to set the first plug out about 8 in. from the separation. The plugs were stuck to the pavement surface by molten sulphur, a method that proved to be ideal for this purpose as they could readily be removed and cleaned after a test and used again.

Center joint loadings

Results of the center-joint loadings are shown in Table I and Fig. 3. The procedure consisted of setting the gage plugs; taking initial readings; placing the truck in position; applying the load on one side of the joint and reading the instruments; shifting the load to the other side and again reading the instruments. Following this, the load was shifted back and forth across the joint by means of the jacks until it was applied 50 times on each side of the separation. Then, with the load resting on one side and subsequently on the other, the instruments were once more placed and read.

The per cent of load transfer was computed from the deflection values listed in Table I, the amount of transfer being considered as directly proportional to the relative deflection of the loaded versus the unloaded side. These values represent the deflection or difference in slab elevation produced by the load over instrument gage lengths 1 and 2. Transfer was based upon these values rather than upon the accumulative deflection of the two slabs (shown in Fig. 3) because in some cases flexure of the pavement extended out farther than the point where the last reading was taken. Regardless, however, of whether transfer was computed from the relative deflection occurring over a common pair of gage lengths or upon the total deflection, the result was practically the same.

Two significant indications are to be noted from the data shown in Table I and Fig. 3. In general, it may be concluded from these results that the condition of joint with respect to opening is probably the most important

Fig. 2—Two types of deformation and deflection instruments for measuring effect of loads on cracks and joints.

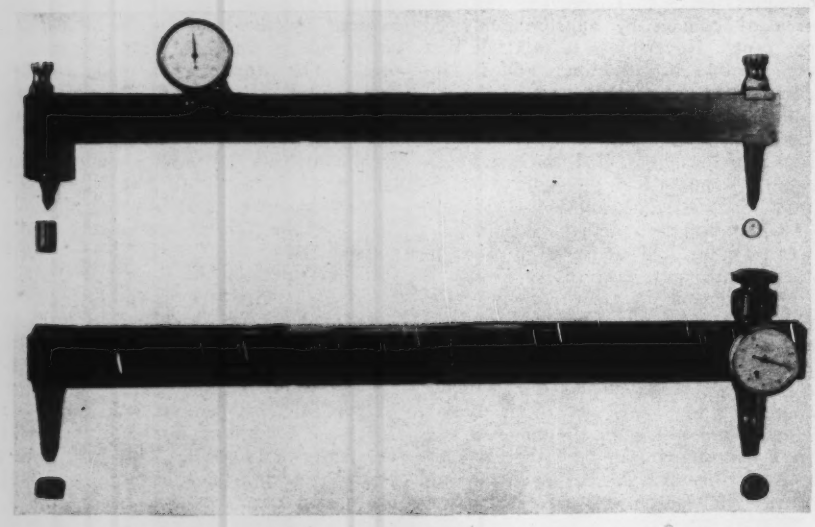
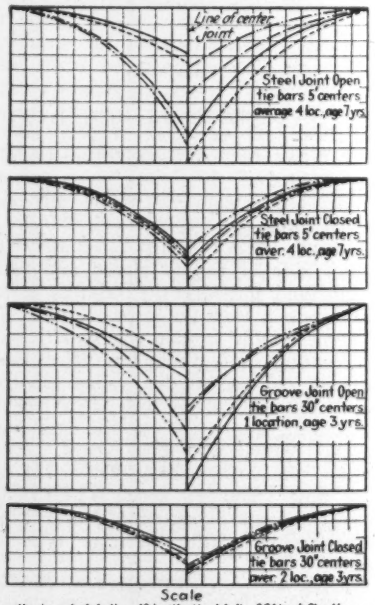


Fig. 3—Deflection curves obtained in loading center joints, computed from the deflection values given in Table I.


Line of center joint
Steel Joint Open tie bars 5 centers aver. 4 loc., age 7 yrs.
Steel Joint Closed tie bars 5' centers aver. 4 loc., age 7 yrs.
Groove Joint Open tie bars 30" centers 1 location, age 3 yrs.
Groove Joint Closed tie bars 30" centers aver. 2 loc., age 3 yrs.
Scale
Horizontal 1 div. = 10 in., Vertical 1 div. = .001 in. deflection
Curve Legend
---- Initial load right side —— Final load R.S. after 50 applications
— — " " left " — — " " L.S. " 50 "

factor governing load transfer. Very little difference, under comparable conditions, is shown in the ability of the deformed plate and the dummy joint to transmit load or to withstand the destructive action of repeated loads. The most significant values in this table, therefore, are those given for all the open and the closed joints, 38 per cent of load 1 and 27 per cent of load 2 being transferred by the open and 50 and 45 per cent by the closed joints. After the alternations of load, the former values are 33 and 25 per cent, respectively, and the latter 48 and 46 per cent.

As is indicated for load 1, the loaded side of the open and closed joints deflected 0.0230 in. and 0.0144 in., and for load 2, 0.0271 in. and 0.0173 in., respectively. After the alternations these values are 0.0238, 0.0135, 0.0253 and 0.0146 in. If the values of deflection are averaged for loads 1, 2, 3 and 4, a reduction in deflection of the loaded side of 40 per cent is shown for the closed over the open joints.

Deflection curves

In Fig. 3 the deflection curves for the average of the open and closed deformed plate and the dummy joints are shown. The similarity in general appearance of the curves, in the case of the two types of open and closed joints, is marked. It can be noted in most of the cases that the accumulative slab deflection is somewhat less after the alternations of load than before. This indicates that the pavement may have been somewhat permanently depressed or deformed by the repetitions of this heavy load.

Transverse-crack tests

The procedure used in the transverse-crack loading tests was precisely the same as that described for the center-joint loadings. One additional observation made involved measurements with a Berry strain gage of the extent of crack opening from the summer to fall and to the winter period. The results furnished by these tests are shown in Tables II and III and graphically in Figs. 4 and 5. In Table II the computed values of per cent load transfer are listed for each individual loading made. Average values are also given for all the cracks in the plain, mesh and bar-mat reinforced pavement.

The ability of aggregate interlock at the line of fracture to transfer load is clearly shown by these values. The average per cent of transfer (summer loadings, plain pavement) indicated for load 1 is 39 per cent; and load 2, opposite side of crack, 31 per cent. After the alternations the corresponding value for load 1 is 36 per cent, and for load 2 it is 32 per cent. In one direction, then, the load transfer fell off 3 per cent, and in the other a gain of 1 per cent is shown from the effect of the repeated applications of load. In the fall an increase of 4 per cent in transfer is shown in one direction, no increase or decrease being indicated in the other. The winter loadings (which, as stated before, were made before freezing of the subgrade occurred) show the same per cent of transfer in one direction and a falling off of 3 per cent in the other from the effect of the alternations. Certainly these comparatively small reductions in per cent load transfer do not suggest an alarming effect from the shearing action induced. The fact that the fall and winter loads were applied in exactly the same spot as the summer loads means, moreover, that the pavement on each side of the crack at each location was subjected to a total of more than 150 applications of the highly concentrated 18,000-lb. load.

In case of the mesh and bar-mat reinforced pavement, average values of transfer for the summer, fall and winter loadings indicate that the steel has served in a most remarkable manner to hold the slabs formed by the cracks tightly together. There is no effect, whatsoever, shown by the alternation of load. This fact strongly indicates that when roughened edges of two slabs are held firmly together, the aggregate interlock may be expected to function perfectly and permanently as a load-transfer medium.

Reinforcement aids transfer

In Table III average values of per cent transfer for loads 1, 2, 3 and 4 are listed together with average values of deflection of the loaded and unloaded slabs. In the summer, according to this tabulation, the cracks in plain pavement transferred 35 per cent of the load, in the mesh reinforced pavement 48 per cent, and in the bar-mat reinforced pavement 48 per cent. In the fall the corresponding values are 10, 47 and 49 per cent, respectively, and in the winter 12, 49 and 48 per cent. Thus it is seen that even during the summer months a smaller percentage of load is transferred across cracks in plain concrete than across those

TABLE II—TRANSVERSE CRACK TESTS

Percentages of Load Transferred
(9-7-9-in. 20-ft. Pavement.—4 Years Old)

Location Reference Number	(A) Initial Load						(B) After 50 Applications (Each Side of Crack)					
	Load 1 (Right Side of Crack)			Load 2 (Left Side of Crack)			Load 3 (Right Side of Crack)			Load 4 (Left Side of Crack)		
	Summer	Fall	Winter	Summer	Fall	Winter	Summer	Fall	Winter	Summer	Fall	Winter
Plain												
M-47 1	40	6	15	36	14	6	38	14	16	35	10	11
2	36	3	10	59	7	18	45	10	12	42	13	16
3	31	7	3	21	6	7	26	7	3	23	6	4
4	45	11	6	9	6	12	39	11	12	10	8	14
US 27 1	44	10	9	47	25	23	37	19	10	52	17	10
2	37	9	12	33	5	19	33	11	6	33	8	15
3	37	10	22	35	9	11	44	12	21	45	5	10
4	39	6	6	43	10	9	37	7	10	45	8	12
Average	39	8	11	31	10	14	36	12	11	32	10	11
Mesh-Reinforced												
US 10 1	42	47	47	57	50	51	47	45	48	46	51	52
2	42	51	49	51	49	48	45	49	51	54	48	48
3	48	42	52	53	48	52	47	51	50	49	46	48
US 27 1	46	47	44	47	51	53	43	49	48	51	50	50
2	49	48	40	41	51	53	50	48	46	52	53	55
3	50	41	46	43	40	51	43	43	47	45	40	44
4	44	51	52	53	41	46	50	51	50	52	42	48
Average	46	46	47	48	48	49	46	48	48	50	47	48
Bar-Mat-Reinforced												
US 10 1	47	43	48	46	52	44	45	42	52	50	50	45
2	48	49	45	47	50	49	49	46	49	49	46	50
3	50	52	50	46	47	49	50	50	48	50	52	50
M-21 1	50	52	50	46	52	44	51	49	47	45	47	44
2	44	45	49	46	48	47	46	48	49	44	48	50
3	49	52	50	48	46	49	43	50	54	56	44	45
4	48	50	48	42	49	52	53	50	49	46	49	51
Average	48	49	48	46	48	47	48	48	50	48	49	48

Weight of steel per square yard:
Mesh, 5.40 lb.
Bar mat, 6.04 lb.
For complete reinforcement details, see Fig. 5.

Effective Area (sq. in. per foot of fabric):

Transverse members	Longitudinal members
.054	.108
.064	.121

TABLE III—TRANSVERSE CRACK TESTS
Slab Deflection Values and Percentages of Load Transferred
(9-7-9-in. 20-ft. Pavement,—4 Years Old)
Loads 1, 2, 3 and 4 Combined (See Table II)

Location Reference Number	Summer			Fall			Winter		
	Deflection (In.)		Per Cent Load Transferred	Deflection (In.)		Per Cent Loaded Transferred	Deflection (In.)		Per Cent Load Transferred
	Loaded Side	Unloaded Side		Loaded Side	Unloaded Side		Loaded Side	Unloaded Side	
Plain									
M-47 1	.0144	.0110	43	.0207	.0026	11	.0201	.0027	12
2	.0086	.0069	44	.0238	.0029	9	.0248	.0039	14
3	.0280	.0097	26	.0311	.0021	6	.0329	.0014	4
4	.0349	.0117	25	.0266	.0026	9	.0228	.0029	11
US 27 1	.0128	.0106	45	.0296	.0068	19	.0295	.0055	16
2	.0389	.0198	34	.0316	.0028	8	.0385	.0056	13
3	.0153	.0112	42	.0311	.0031	9	.0309	.0061	16
4	.0153	.0105	41	.0314	.0026	8	.0268	.0026	9
Average	.0210	.0114	35	.0282	.0031	10	.0283	.0038	12
Mesh-Reinforced									
US 10 1	.0125	.0107	46	.0135	.0125	48	.0121	.0118	49
2	.0125	.0116	48	.0132	.0129	49	.0119	.0114	49
3	.0148	.0143	49	.0136	.0121	47	.0135	.0138	51
US 27 1	.0172	.0151	47	.0143	.0143	50	.0125	.0118	49
2	.0119	.0112	48	.0131	.0132	50	.0110	.0102	48
3	.0178	.0146	45	.0235	.0167	42	.0157	.0140	47
4	.0098	.0097	50	.0112	.0099	47	.0098	.0093	49
Average	.0138	.0125	48	.0146	.0131	47	.0124	.0118	49
Bar-Mat-Reinforced									
US 10 1	.0111	.0099	47	.0104	.0094	47	.0104	.0092	47
2	.0121	.0111	48	.0091	.0083	48	.0094	.0087	48
3	.0126	.0122	49	.0129	.0128	50	.0141	.0137	49
M-21 1	.0167	.0156	48	.0135	.0140	51	.0127	.0110	46
2	.0136	.0117	46	.0153	.0138	47	.0099	.0094	49
3	.0146	.0138	49	.0137	.0127	48	.0090	.0085	48
4	.0130	.0118	48	.0113	.0108	49	.0084	.0082	49
Average	.0134	.0123	48	.0123	.0117	49	.0106	.0098	48

in pavement containing reinforcement. The falling off in transfer from 35 to 10 per cent in case of the plain pavement from summer to fall is due, as will be shown later, to opening of these cracks. The temperature at the time of the winter loadings was actually somewhat higher than when the autumn tests were made, and to this fact may be attributed the apparent inconsistency in these two series of results.

A consideration of the deflection values listed in Table III reveals some very interesting facts. When two slabs deflect an equal amount, the per cent of load transfer is obviously 50 per cent. If the ratio of deflection is 3 to 1, loaded to unloaded side, the per cent transfer is 25 per cent. In case, then, the amount of transfer is low, the loaded slab is obviously deflected and stressed to a much greater extent than if the load transfer is high. This is clearly evident from the values listed in Table III.

The deflection over gage lengths 1 and 2 of the loaded slabs (summer tests, plain pavement) is 0.0210 in.; for the mesh-reinforced pavement 0.0135 in.; and for the bar-mat reinforced pavement 0.0134 in. The difference in amount of transfer between the plain and reinforced pavement thus resulted in an increase of deflection of the loaded slab to the extent of about 54 per cent. In the fall this increase figures 109 per cent, and in the winter 146 per cent.

It is significant, further, to note that from summer to fall the deflection of the plain pavement, loaded side of crack, increased 44 per cent as against 6 per cent for the mesh reinforced. Simultaneously, the deflection of the bar-mat pavement decreased 8 per cent. While the increases in deflection cited do not necessarily mean the same proportional increase in stress, they do point to a decidedly more severe load effect upon the pavement not containing reinforcement.

The above discussion, as stated before, is based entirely upon the average values listed in Table III. It is true that when individual values are considered some inconsistencies are shown. For example, the loaded-slab deflection of location M-47-2. in the summer was 0.0086 in., which is less than the average of any single location in the reinforced slabs. The same location, however, in the fall showed a deflection of 0.0238 in., a value much greater than the average of the reinforced. Such variations or apparent inconsistencies are to be expected as the soil conditions, degree of pavement warping and other uncontrolled variables enter into the problem. It was not possible, of course, to select slabs having only one crack near the middle, all upon subgrade of exactly similar character or condition.

It is clearly evident from these test data that the degree of subgrade support is not apparently as important a consideration in so far as deflection or stress of pavement is concerned as adequate load transfer. When the summer loadings were made, the subgrade generally was fairly dry and firm. The fall loadings were run after a prolonged rainy period. In spite of this fact, the deflection of the reinforced pavement indicates very little change in support. Although the plain pavement showed a considerable increase in deflection (34 per cent), this obviously is due largely to decrease in load transfer from 35 to 10 per cent incident to the greater width of the crack.

In Fig. 4 (left) deflection curves are shown from which the relative behavior of the three designs of pavement (plain, mesh and bar-mat reinforced) can be easily seen. It will be noted that the loaded and unloaded side of the cracks in the reinforced pavement deflect to approximately the same extent regardless of the time of year of test, while in the case of the plain pavement there is a marked difference, particularly for the fall and winter period. In Fig. 4 (right) these curves are regrouped in order to show the effect of time of loading more clearly. Here again the difference in behavior of the three designs of pavement is emphasized.

Fig. 5 shows a relationship of the per cent load transferred by the cracks in the three designs of slab to the extent of crack opening. As mentioned before, the separation occurring at each of the cracks from the summer to fall to winter period was measured with the Berry strain gage. The per cent of load transfer computed from the fall and winter deflection values was plotted against the corresponding crack opening observed. A marked difference is shown by this chart in amount of crack opening in case of the reinforced and plain pavement, as well as in the corresponding per cent of load transfer. The average extent of opening of the reinforced cracks is indicated to be less than 0.005 in. compared to about 0.100 in. for the plain. Thus the cracks

in plain pavement subjected to the loading tests opened to an extent approximately twenty times as great as those where the slab was reinforced. It is not known, of course, to what extent the cracks in either design may have been open when the summer loading tests were conducted. Apparently, however, judging from the amount of load transfer a greater width of opening existed in case of the plain pavement cracks. The infiltration of dirt or maintenance material into these cracks when they were open more than likely prevented them from closing completely during the summer period. It is felt that these data supply the reason for the difference in load transfer observed in the tests of plain and reinforced pavement.

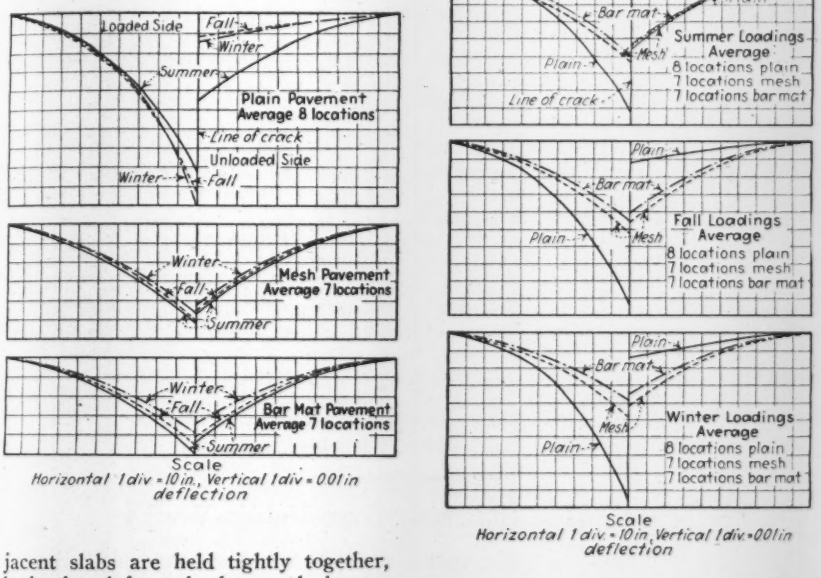
Summary discussion

Information disclosed by the center-joint loading tests indicates that if adjacent slabs are held tightly together, both the deformed plate and dummy joints may be expected to transfer load efficiently. It was found, where separation at the surface of the slab had developed, that amount of transfer was less. Repeated applications of load across either type of joint, even when slightly open, did not appear to have the effect of further decreasing ability to transfer load.

The fact that trouble was experienced in locating center joints, particularly of the dummy type, where separation had occurred, prompted the transverse-crack loading tests. Here the opportunity was presented to study the ability of aggregate interlock to transmit load under variable conditions with respect to width of crack opening. The test results previously discussed clearly and conclusively indicate that the irregular fractured faces of a concrete slab are effective in transmitting load in shear.

While the investigation was planned and conducted primarily for the purpose of procuring information on the load-transfer properties of joints, certain facts were developed by the crack-loading tests which unquestionably point to the justification of the use of reinforcement. The results show that load transfer across fourteen cracks in reinforced pavement suffered practically no reduction from summer to winter, whereas in plain pavement a reduction of 66 per cent occurred. The deflection of the plain pavement, loaded side of crack, as stated before, was 54 per cent greater than the reinforced in the summer, 109 per cent greater in the fall and 146 per cent greater in the winter period.

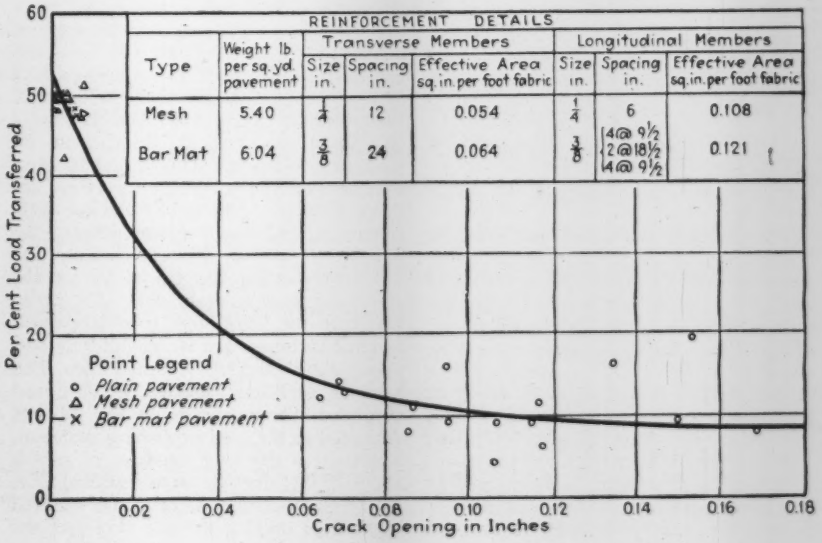
Fig. 4—Deflection curves obtained in loading transverse cracks (left) according to type of reinforcement, and (right) according to season of year.



It is true that the ability of reinforcement in the amounts used to hold two 50-ft. slabs together permanently may well be questioned. According to theory, there would be required over 5.5 sq.in. of steel longitudinally in a 20-ft. slab to prevent the development of wide-open cracks, assuming a coefficient of subgrade friction of *2*. Although the actual area of longitudinal steel in the mats used in the tested slabs is considerably less than half this amount, not one of the fourteen cracks subjected to test had opened to any appreciable extent, at least certainly not to the point of rupturing the steel. It should be stated in this connection that pavement survey records show that all the cracks loaded in this investigation had been in existence at least two years prior to the test. The above constitutes evidence to the effect that the pull or drag of the subgrade is less than that assumed, or the figure of 25,000 lb. per square inch, yield point of the steel, used in the computations, is highly conservative.

Information furnished by a special inspection in April, 1933, of several pavements built in 1925, portions of which were mesh-reinforced, is of special interest in the above connection. The details of the mesh-reinforcement mats used in these pavements were identically the same as those installed in the slabs subjected to the loading tests (Fig. 5). By cutting the shoulder material away from the slab edge it was possible to measure roughly, with a steel scale, the width of those cracks existing in both the plain and reinforced sections. It was found, on averaging the figures obtained, that regardless of the number of transverse cracks in 100-ft. reinforced slabs, the extent of opening was about the same, varying only from 0.040 to 0.050 in. For one

Fig. 5—Relation of crack opening to per cent of load transferred.



full transverse crack per slab, it was 0.042 in.; for two, 0.050 in.; for three, 0.046 in.; and for four full transverse cracks it was 0.040 in. In the plain pavement, on the other hand, the extent of opening, as anticipated, decreased as the number of cracks increased. For one full transverse crack to a slab, the average opening was 0.15 in.; for two, 0.10 in.; for three, 0.08 in.; and for four it was 0.10 in., the latter figure being somewhat inconsistent. Judging from these data, the longitudinal steel (2.16 sq.in.) was effective in preventing opening of the cracks beyond a certain fixed limit. Whether the steel actually elongated to the extent indicated by the measurements (about 0.050 in.) or whether this width of opening merely existed or developed on the edge is, of course, not known.

Pavement design

That the data furnished by this series of loading tests are significant from a standpoint of design should be a foregone conclusion.

It is an established fact that the thickened-edge pavement section, whether plain or reinforced, used in conjunction with an adequately tie-barred center joint constitutes a well-balanced design of slab transversely. This is because (1) no trouble is experienced in effectively holding two 10- or even 12-ft. slabs together against the pull of the subgrade by the use of tiebars; and (2) longitudinal cracking is eliminated by the center joint. This is in marked contrast to the situation that confronts the designing engineer in a longitudinal direction. Here the pavement is more or less infinite in length, and the problem of strengthening free edges adjacent to transverse joints or cracks is much more difficult.

As the concrete contracts, joints and cracks will open, and, while tiebars should hold two 10-ft.-length slabs in contact in this direction just as effectively as in a transverse direction, there is naturally a limit to the number of such slabs, or length of pavement, that may be linked or held together in this manner. The same line of reasoning is applicable to the use of distributed reinforcement. There is obviously a limit to the length of slab which a certain weight of reinforcement may be expected to hold together in event cracking occurs.

The fact that the fourteen transverse cracks in the 20-ft. reinforced pavement subjected to the loading tests had been held to fine dimensions by less than 2.50 sq.in. of steel does not necessarily mean that this amount is adequate for 100-ft. slabs. It is the opinion of the writer, however, from studying the behavior of pavements in service and from the loading tests discussed in this report that, with few exceptions, it would function effectively in holding cracks to fine dimensions and thereby balance the load resistance of the slab between transverse joints. Certainly the use of distributed reinforcement, weighing 6 lb. per square yard and having twice the effective area longitudinally as transversely, should be entirely adequate in slabs of less than 100 ft. in length, say 60 ft.

Of course, completely to balance the load resistance of a slab longitudinally, free thin edges adjacent to joints must be strengthened. In fact, the weakest point may be next to expansion joints where the slab edges are vertical and no mechanical interlock is provided. Here the slabs are practically independent of one another at all times of the year. Thus, from a structural viewpoint, it is far more important to strengthen such edges than to provide for edge-strengthening within the slab.

There are a number of ways in which transverse-joint edges can be strengthened. The idea of edge-thickening never attained much popularity because it requires cross-channeling of the subgrade and tends to promote transverse cracking by the anchoring effect of the thickened ends. The use of slip dowels, the oldest method of providing mechanical interlock, is, according to R. D. Bradbury, a somewhat questionable means of rendering joints shear-resistant owing to bending in the dowel itself and the largely uncertain intensity and distribution of its bearing on the concrete. ("Design of Joints in Concrete Pavements," paper delivered at the twelfth annual meeting of the Highway Research Board.)

While there are several other methods of edge-strengthening, the one of unusual promise involves the use of special load-transfer joints, a number of which have lately been introduced on the market. The Michigan state highway department just recently completed the construction of an experimental section of pavement containing a number of different types of these joints. It is planned to subject these to the 18,000-lb. repeated-load test and thereby to establish their value with respect to transfer. Many other states, realizing the importance of efficient transverse-joint edge-strengthening, have installed joints of the above type for similar purposes.

Based upon the assumption that these special joints will provide an efficient, positive and economical means of edge-strengthening, the design of thickened-edge pavement suggested by the writer is as follows:

Slab Dimensions

Width — 18, 20 or 22 ft.
Cross-section — 8-6-8 or 9-7-9 in.
Length — 60 ft.

Joints

Longitudinal:
Deformed plate or dummy.
Tiebars, ½-in. diameter, 40- to 48-in. centers.
Transverse:
Expansion:
¾-in. width—mechanical interlock for transferring load.
Dummy:
Use not advocated (cracks would be held to inconspicuous dimensions by the reinforcement, perhaps to such an extent that tarring would not be necessary).

Reinforcement

Weight—6 lb. per square yard.
Longitudinal members—spacing 6 in.
Effective area about 2.50 sq.in. per 20-ft. width.
Transverse members—spacing 12 in.
Effective area about 1.25 sq.in. per 20-ft. length.

The fact that no free or semi-free edges would exist in this design of slab and that it would thereby be truly balanced both in a transverse and a longitudinal direction, suggests the possibility of effecting a substantial reduction in thickness of cross-section over that of plain non-interlock jointed pavement without the sacrifice of structural resistance.

Factory Jobs Created Indirectly from Public Works

THE FACT that a public-works project provides a substantial number of indirect jobs as well as field or direct jobs is well illustrated by some data that L. M. Christie, vice-president and general manager of the National Fireproofing Corp., has assembled relative to a clay-conduit installation in Kalamazoo, Mich. This city has been progressive in attempting to relieve its unemployment by public-works construction, and one project initiated by the City Manager, Edward C. Rutz, involved removing the tracks of an old street-car system and, while the street was torn up, installing an underground conduit to house the street-lighting and power cables and traffic-signal lines. The benefits derived from the job did not stop with the workmen on the job but extended to the men producing material. Relative to the clay conduit, of which about 75,000 duct-ft. were installed, Mr. Christie states that sixteen men worked eight days mining the fire clay and the coal that went into the conduits. Forty-five men worked eight days conveying the raw clay to the plant, pulverizing it, tempering it to the proper consistency, feeding it into extrusion machines, cutting it into lengths and placing it on dryer cars for introduction into the kilns. Twenty-one men worked eight days conveying dry clay to the kilns, placing the unburned conduit carefully inside, keeping the kilns at a temperature of 2,000 deg. for the requisite 72 hours and introducing the necessary chemicals to produce the glazed surface on the tile. Nine men worked eight days inspecting each piece of conduit, and seven men worked eights days conveying the conduit to railroad cars and packing it to insure its arrival in perfect condition on the job. Finally, there was the benefit to all the employees of the railroad in transporting the conduits. Conduit-installation work in Kalamazoo has been under the direction of Earl E. Norman, director of public utilities.

Status of the $400,000,000 Highway Program

Contracts awarded for 67 projects, and plans and specifications approved for 465 projects—Progress chart shows planned expenditures and employment for 16 months

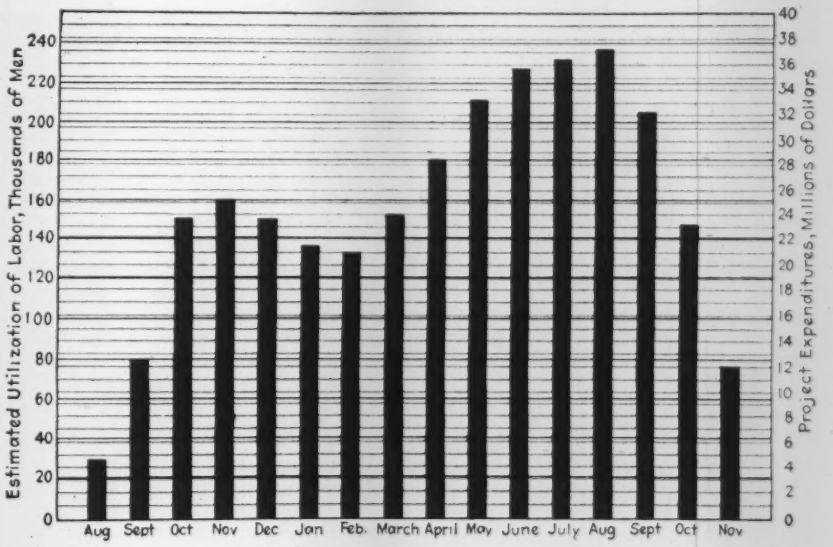
THE National Industrial Recovery Act became law June 16, 1933. In that part of the act (part II) providing a possible $3,300,000,000 for public-works construction a sum of $400,000,000 was specifically named as a donation to states and territories for highway construction. The act defined in what proportions this huge sum should be distributed among the states and what classes of roads were to be constructed, and it set minimum expenditures for certain classes.

Operating under this act, contracts had been awarded for 67 road projects as of Aug. 18, 1933. Plans, specifications and estimates had been approved for 465 projects, the estimated cost of which was $32,365,455. The complete chronology of activities is summarized in the accompanying tabulation.

Requirements of act

The general requirements of the recovery act for highway construction have been indicated. Specifically, not less than one-quarter of the expenditure in every state must be for secondary roads, and one-quarter for roads in municipalities; not more than one-half can be applied to state highways, and this state road portion can be cut down and the cut added to the allotment for either or both of the other classes of roads. The secondary and the city road allotments cannot be reduced. It was also stipulated that expenditures must be distributed over at least 75 per cent of all the counties of the state.

The administration plan under which the provisions of the law have been executed provided that each state should report the percentage distribution between state, municipal and secondary projects of the funds allotted to it by the act. With this distribution approved, each state was required to submit a full program tentatively listing each project for each class of road and giving its location, length, type of construction and estimated cost. Approval of the full program had then to be followed by submission by the states of plans, specifications and cost estimates for each project. These could be submitted one or several at a time, and they received consideration as submitted. With approval by the Bureau of Public Roads, the states are free to advertise for bids and award contracts. Construction then proceeds under the rules and regulations established by the bureau.



Estimated utilization of labor and money by months under the appropriation of $400,000,000 for roadbuilding provided by the National Industrial Recovery Act.

Effect on progress

The procedure outlined had a definite effect on progress. While the preliminary programs asked for were tentative, they required a determination by a state highway department of its entire operation under this emergency appropriation. Two classes of projects were introduced: *(a)* municipal highway projects; and *(b)* secondary-road projects, of which the state highway department in general had not previously had direction or control. These new classes of projects had to account for at least half of the state appropriation.

Briefly, the state had to start from the beginning in selecting the roads for a half or more of its total expenditure, and to make the selection in a field unfamiliar in detail to its road officials. This consumed more time than was required to select state highway projects with which the officials were familiar. As shown by the accompanying tabulation, the state projects have therefore predominated until now among projects finally approved. Further to delay progress, distribution of the work had to be made among at least three-quarters of the counties of the state.

In previous emergency-appropriation expenditures, approval by the district engineers of the Bureau of Public Roads of plans and specifications had been followed in part, but it was made a fixed rule in the present administration of operations. As indicating the task quantitatively, Illinois presented a program of 300 projects; these had to be selected so as to distribute the work over 78 counties; plans and specifications have to be prepared for each project, and these plans and specifications have to be approved for each project.

PROGRESS AS OF AUG. 18 IN $400,000,000 HIGHWAY PROGRAM

Law passed June 13, 1933.
Certificate of allocation of funds to states, June 23, 1933.
Rules and regulations issued, June 23, 1933.
First programs approved, New York and Utah, July 12, 1933.
Program status as of Aug. 18, 1933:
- Approved in whole or in part—45 states.
- Ready for approval — 3 states.
- Not received — 2 states.
  - (Of these two, one is Georgia where the present highway board has not yet been recognized.)

First contracts awarded:
- Two in Utah, July 31.
- Four in Vermont, Aug. 4.

Projects awarded to date, 67.
- Plans, specifications and estimates approved by bureau, advertised or ready for advertising:

State highway projects	368
Municipal highway projects	79
Secondary road projects	16
Park and forest road projects	2
Total projects	465

States represented, 26 and District of Columbia.
Estimated cost, $32,368,455.
Estimated employment, 41,119.

The aggregate of operations of selection, preparation, submission and approval is a larger round number for some states and a smaller one for most states, but for all 50 states and territories it makes a substantial total.

A general construction schedule or progress chart was prepared by the Bureau of Public Roads. This was based on the presumption that "It is imperative that construction of highway projects be begun as early as possible and pushed to completion to furnish the maximum of employment when it is most needed and to increase purchasing power and stimulate industry generally. Study should be made of the approved state programs with this end in view, and, in addition, suitable projects should be selected and their award timed to insure a maximum of winter work. Grade-crossing eliminations, which usually may be protected from severe weather and thus continue under construction throughout the winter, should be given consideration, as well as grading projects suitably located so as to give a maximum of employment where unemployment is most serious."

The preparation of this chart was facilitated by the very definite understanding between state highway departments and the federal bureau, provided by the approved programs, as to the major number of projects to be undertaken and the sizes, types and locations of these projects. It is expected also that the full programs will have the effect of steepening the progress curve to a peak when the break from preparatory work to actual awarding of contracts takes place. To expedite the letting of contracts, the Bureau of Public Roads took two actions:

1. An optional regulation was adopted permitting curtailment of time between first advertisement and the taking of bids to fourteen days.

2. Payments to contractors and others will be speeded up by the federal establishment of revolving funds where the states are not in position either through legal restrictions or lack of available treasury balance to provide revolving funds themselves.

Based on the progress curves of contracts let in the two previous emergency appropriations for roadbuilding, which ran nearly parallel, a lag of between one and two months was assumed between appropriation of funds and the active letting of contracts. Starting with August, the progress chart was laid down as shown by the accompanying illustration. This shows the expected expenditure and volume of employment for each month for sixteen months.

Fast progress in the awarding of contracts is expected to begin in September, and by November to have reached a peak for this year. Following a winter lag, the contract commitments will increase to a peak of about $37,000,000 and a payroll of nearly 240,000 men in August, 1934.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Simple Steel Structures

THE DESIGN OF SIMPLE STEEL STRUCTURES—By Clyde T. Morris. Cloth; 6x9 in.; pp. 279; diagrams and tables. Published by McGraw-Hill Book Co., Inc. New York and London. $2.50.

While this book is classified as the fourth edition of a book published under the title of "Designing and Detailing of Simple Steel Structures," it is in reality a combination of that book with much of the substance of "Stresses in Structures," by the late A. H. Heller, a book that Professor Morris revised and enlarged in 1916. Consequently, the present book covers both stresses in, and the design of, simple steel structures. It is prepared especially for advance undergraduate students who have finished a course in theoretical mechanics and strength of materials.

* * *

Small City Planning

PLANNING IN THE SMALL AMERICAN CITY—By Russell Van Nest Black. Paper; 8x10 in.; pp. 90. Published by Public Administration Service, 850 East 58th St., Chicago, Ill. $1.

Much of the published material relating to city and regional plan work deals with the problems of large cities and metropolitan regions. This book is directed toward meeting the requirements of the small city of population under 50,000. It is divided into three major parts: "Making the City Plan," "What Planning Offers to the Small City" and "Carrying Out the City Plan." The books deals with these elements alone, and is not primarily a technical treatise on planning design. It attempts to show not only how the planning should be done, but also the ways in which it may go wrong.

* * *

Electric Distribution Cost

WHAT ELECTRICITY COSTS—A Symposium, edited by Morris Llewellyn Cooke. Paper; 5x7 in.; pp. 231; halftones and tables. Published by New Republic, Inc., New York. $1.

The full title of this litlte book, "What Electricity Costs for Home and on the Farm," is a better key to the real subject of the book than the list title of "What Electricity Costs," for its concern is not what electricity costs to generate in the power plant, but whether the small consumer of current is not being unduly burdened with costs that pile up between the generating plant and the consumer's meter. Electric utilities generally have maintained that it is not possible to segregate and assign to the various classes of consumer their actual share of the cost of distribution. Rates between the several classes of consumers, therefore, have been fixed arbitrarily. This book is prepared primarily for the use of those who are not content to accept this arbitrary assignment of high distribution costs to the small consumer of electric current and little to the large consumer. It contains a group of papers and discussions presented early this year before the "Institute of Public Engineering," held in New York. According to the publisher's announcement, the book points the way to lower, fairer rates and to all the benefits lower rates bring. That, in a few words, sums up the way in which the subject was approached when the Institute was organized. The discussion was directed toward producing evidence that the cost of electricity to the small consumer is too high.

Recovery Act

THE NATIONAL INDUSTRIAL RECOVERY ACT—By Benjamin S. Kirsh in collaboration with Harold Roland Shapiro. Cloth; 5x7 in.; pp. 156. Published by Central Book Co., New York. $2.50.

LABOR RELATIONS UNDER THE RECOVERY ACT—By Ordway Tead and Henry C. Metcalf. Cloth; 5x8 in.; pp. 259. Published by Whittlesey House, McGraw-Hill Book Co. Inc. New York. $2.

BUSINESS UNDER THE RECOVERY ACT—By Lawrence Valenstein and E. B. Weiss. Cloth; 5x8 in.; pp. 314. Published by Whittlesey House, McGraw-Hill Book Co., Inc., New York. $2.50.

OBVIOUSLY, with all matters relating to the National Industrial Recovery Act in a state of flux, little can be said today concerning its effect on industrial conditions with any assurance that the statement will be valid tomorrow. The law is so general and the powers it confers upon the President are so broad that its ultimate effect will be governed more by the interpretations put upon it by the administrators than by the provisions of the law itself. This fact must be taken into consideration in reading any one of the books on the Recovery Act that have been prepared in the brief period since the act was passed. The three books here noted relate to the effect of the act upon industry, upon labor and upon trade associations. In so far as they attempt to be specific as to the exact meaning of the act or as to what effects it is going to produce, caution

should be exercised in accepting the author's conclusions. The chief value of the books lies in their survey of industrial and business conditions as of the date the act went into effect, their review of labor conditions and their analysis of trade associations. This material will be of value to the reader in understanding the act as it is applied to industry during the coming months.

Miscellaneous Notes on Booklets and Reprints

A STUDY OF THE MECHANIC LIEN LAW of the state of New York has been published by the Central Book Co., 245 Broadway, New York City, under the title of "Other People's Labor and Materials in the Building Industry of Greater New York." Price, $1.

STRENGTH TESTS OF TIMBER in structural sizes is the subject of Part 7, Vol. XVII, The Indian Forest Records. The results of tests up to 1932 are included. Copies may be obtained from the Manager of Publications, Government of India, Delhi, India. Price, 1s. 9d.

DIVERSION OF SEDIMENT at branching channels, a paper by Gerard H. Mathes before the American Geophysical Union, has been reprinted from the *Transactions* of the 14th annual meeting. Copies may be obtained from Mr. Mathes, office of the president, Mississippi River Commission, Vicksburg, Miss.

SLUM CLEARANCE was the subject of a conference held in Cleveland early in July of this year. The papers presented at that time and the discussion of them now have been assembled in the form of *Proceedings*. Copies may be obtained from the National Conference on Slum Clearance, Union Trust Building, Cleveland, Ohio. Price, $3.

A CODE FOR PROTECTION AGAINST LIGHTNING has been published by the U. S. Bureau of Standards as "Handbook No. 17." It supersedes "Handbook No. 12," formerly M-92. The handbook is divided into three parts: Part I, Protection of Persons; Part II, Protection of Buildings and Miscellaneous Property; and Part III, Protection of Structures Containing Inflammable Liquids and Gases. Copies may be obtained from the Superintendent of Documents, Washington, D. C., for 15c.

STEEL FRAMING FOR SMALL RESIDENCES is covered in a booklet bearing that title published by the United States Steel Corporation, 71 Broadway, New York. The subject is approached from the point of view of the needs of builder of houses of non-standard design rather than the producer of mass-production houses. For this purpose the booklet gives a suitable variety of rolled-steel sections with their characteristics and simple rules for their use. Copies may be obtained from any of the subsidiaries of the United States Steel Corporation. Price, 50c.

INFORMATION ON THE STRUCTURAL EFFECT of the Southern California earthquake of March 10 in addition to that already given in these pages is given in a report of the committee on fire prevention and engineering standards, National Board of Fire Underwriters, 85 John St., New York. Special attention is paid in the report to the effect upon tanks, piping and other elements of the water-supply and fire-protection system.

RESULTS OF LABORATORY EXPERIMENTS conducted at the U.S. Waterways Experiment Station, Vicksburg, Miss., are given in the first of two papers of the second series prepared by the station, Paper No. 10, "Experiment to Determine the Effect of Mississippi River Backwater on the Red River," and Paper No. 11, "Model Studies of Dike Location." Copies may be obtained from the president, Mississippi River Commission, Vicksburg, Miss. Paper No. 10, 15c. Paper No. 11, 50c.

A SERIES OF DESIGN CHARTS for concrete beams has been prepared by Odd Albert, structural engineer. The charts cover such problems as design of tension and compression parts of the section, design of compression and tension steel, design of beams for compression only, design of beams for both compression and tension, spacing of stirrups, number of stirrups, etc. The charts are published by the Opla Co., P.O. Box 66, East Orange, N. J. 20c. each.

THE MANY STANDARDS set by the American Standards Association, 29 West 39th t., New York, are classified and listed in the American Standards Year Book, 1932-33, recently put out by the association. In issuing the Year Book the association called attention to the fact that recently the federal government transferred certain functions of the U.S. Bureau of Standards to the American Standards Association. This includes the work the bureau had been doing in the field of simplification, commercial standards, safety codes and building codes.

AN APPROXIMATE MEASURE of earthquake effect on framed structures is the subject of an 80-page mimeographed pamphlet by R. S. Chew, consulting engineer, San Francisco. The author begins with a review of foundation materials, noting their susceptibility to seismic movement. He then takes up various building types, illustrating the effect of earthquake shock on different classes of construction, with specific reference to reports from the Tokio and San Francisco disturbances. As a result, general specifications are proposed for various types of buildings, considering both rigid and flexible frames. The last third of the book is devoted to a mathematical treatment of the theory developed. The price is $2.50.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ARCH DAM INVESTIGATION: Volume III—Cloth; 6x9 in.; pp. 194; photographs, diagrams and tables. Published by the United Engineering Trustees, Inc. for The Engineering Foundation, 33 W. 39th St., New York. $3. (Members, $2.)

DEBT AND PRODUCTION—By Bassett Jones. Paper; 6x9 in.; pp. 147; diagrams and tables. Published by The John Day Co., Inc., New York. $2. Cloth bound $2.50.

FEDERAL REGULATION OF MOTOR TRANSPORT—Reprints and bibliographies compiled by Helen M. Muller. Cloth; 5x8 in.; pp. 154. Published by The H. W. Wilson Co., New York. 90c.

THE FRESH-WATER ALGAE OF THE UNITED STATES—By Gilbert M. Smith. Cloth; 6x9 in.; pp. 716; diagrams. Published by McGraw-Hill Book Co., Inc. New York and London. $6.

GEWICHTSSTAUMAUERN UND MASSIVE WEHRE—By N. Kelen. Cloth; 8x11 in.; pp. 374; photographs, diagrams and tables. Published by Julius Springer, Berlin. 52 RM.

DER INDUSTRIEBAU: VOLUME II, PLANUNG UND AUSFUHRUNG VON FABRIKANLAGEN—By Erich Heideck and Otto Leppin. Cloth; 8x11 in.; pp. 309; halftones, diagrams and tables. Published by Julius Springer, Berlin. 52 RM.

THE IRREPRESSIBLE CONFLICT—Business Vs. Finance—By David Cushman Coyle. Third Edition. Paper; 5x9 in.; pp. 45. Published by David Cushman Coyle, 101 Park Ave., New York. 60c.

MITTIG GEDRÜCKTE SÄULEN, HEFT 2—By A. Kleinlogel and K. Hajnal-Kónyi. Paper; 7x11 in.; pp. 52; diagrams and tables. Published by Wilhelm Ernst & Sohn. 4.60 RM.

MODERN INDUSTRIAL ORGANIZATION—A translation of Der Moderne Industrialismus. By Herbert Von Beckerath. Cloth; 6x9 in.; pp. 385. Published by McGraw-Hill Book Co., New York and London. $4.

MULTIPLE LENS AERIAL CAMERAS IN MAPPING—By the Technical Staff of the Fairchild Aerial Camera Corporation. Cloth; 6x9 in.; pp. 161; photographs, diagrams and tables. Published by Fairchild Aerial Camera Corp. New York. $5.

PRAKTISCHE BAUSTATIK—By Stephan Szegö. Paper; 8x11; pp. 238; diagrams and tables. Published by Selbstverlag des Verfassers, Berlin. 18 RM.

REINFORCED CONCRETE—MECHANICS AND DESIGN—By Robert A. Caughey. Paper; 8x11 in.; pp. 114; diagrams and tables. Published by Iowa State College Book Store, Ames, Iowa. $2.70.

STEEL CONSTRUCTION: Handbook No. 20-A.—Cloth; 7x9 in.; pp. 327; tables and diagrams. Published by R. A. Skelton & Co., Moorgate Station Chambers, London. 10s. net.

TWENTY-FIVE YEARS OF CHEMICAL ENGINEERING PROGRESS—Edited by Sidney D. Kirkpatrick. Cloth; 6x9 in.; pp. 373; tables and diagrams. Published by D. Van Nostrand Co. Inc., New York.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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Roadbuilding Set to Go

RAPID acceleration in putting the $400,000,000 highway program under construction can be expected with the beginning of September. The routine of getting state programs approved and clearing the way for putting projects under contract is virtually over, as explained elsewhere in this issue. Operations are in the hands of the efficient organizations of the Bureau of Public Roads and of the state highway departments, and delay due to superimposed administration may be expected to be negligible. A construction schedule has been worked out which looks to the commitment of the entire four hundred millions in sixteen months, reaching a peak employment of a quarter of a million men in July and August of 1934. Extra facilities for speeding action by state highway officials have been set up by orders limiting the advertising period for bids and by establishing in states a revolving fund to meet estimates immediately without provision of state funds. In all respects the way seems cleared for rapid progress in getting road contracts awarded, orders going in for equipment and materials, and wages being paid.

A Hazard Extended

VIRTUALLY a season's work has been lost by the delay in allotting money from the public-works fund for continuing flood-protection operations on the Mississippi River. The belated allotment of $7,000,000 provides for scarcely more than a continuation of operations being conducted by the Mississippi River Commission forces in stream and revetment investigations and some miscellaneous construction. Contract construction of new levees and contraction works cannot be undertaken. Substantially all the vast and costly construction plant assembled on the river to carry on the continuing program contemplated in the flood-control act of 1928 is thus rendered idle. Already some 15,000 men have been thrown out of employment, and this number will soon be increased. These facts are an impressive commentary on the misdirection of effort by the new public-works administration in seeking future fields of prospective employment to the loss of men and plant already at work. And the situation on the Mississippi is further aggravated by the fact that levee construction delayed now increases the hazard of destructive flooding of the lower Mississippi valley next spring.

Supplemental Codes Vital

SUCCESSFUL enrollment of the heterogeneous agencies of construction under a basic code of fair practice is an accomplishment of such merit that it offers high hopes that the important work that remains to be done by supplemental codes will be successfully carried out. There are many factors for which these supporting codes must provide if construction is to be stabilized. The basic code, as drafted, limits wages and hours of work and pronounces definitely against bid peddling. Its remaining provisions touch on few of the functional ills that have become chronic in construction. Of the problems of sound credits, contract surety and stabilized employment no mention is made. These and many other details are left for adjustment to the supplemental codes. It is logical that this should be so. This fact, however, should not blind contracting and engineering to the duties imposed on them to purify their practices by cleansing them of injustices long prevalent. These evils must be taken up in the supplemental codes, specifically named and brought under definite rules. Without such support and reinforcement the basic code offers but a share of the regulation and reform that construction really needs. The supplemental-code makers now at work can prove either a constructive force in stabilizing their industry or assume rank as additional bodies of phrase-makers. Their choice of position should not be in doubt.

Essential Study

A SURVEY of less-than-carload freight handling has been begun by Joseph B. Eastman, Federal Coordinator of Transportation, as one of several studies to be conducted under the coordinator's direction to form the basis for additional railroad legislation at the next session of Congress. The less-than-carload freight survey is of special interest to engineers because it is bound to have an important bearing on one of their principal fields of activity in railroad work, the design of railroad terminals. This study will give special attention to the application of trucks, trailers, demountable truck bodies, container cars, sectional cars, automotive rail trucks and interchangeable rail and highway equipment. Application of these facilities to "store-door delivery" will be included. Such a study has been needed for a long time, but never could it hold out the same prospect for fruitful results as at the present time, when the pending application of a code to the trucking industry under the NIRA promises to bring stabilization of hours and wages into that industry. Heretofore, because of the irregular hours and wages of truck operators, it has not been possible to determine accurately the economic limit of freight handling by truck in competition with rail handling. Unhampered by tradition, the Eastman survey may be expected to bring forth recommendations for radical changes in terminals, in current terminal practices and in the handling of less-than-carload freight. Many believe that the study will raise serious question as to the economic justification for the maintenance of railroad terminals on high-value lands close to the centers of large cities and will call for a new type of outlying terminal.

Reservoir Levels

DROUGHT brings a twofold problem to those charged with the control of storage reservoirs. Not only must they endeavor to make the most of their reserve supply without being improvident, but they must also try to satisfy the demands of summer campers along the reservoir shores who are annoyed by any fall in lake level. And it is surprising how big an issue can be made

of a trivial inconvenience to the occupants of a group of camps and how easy it is to make the public believe that the party controlling the reservoir level is in the wrong, and that it is taking something from the public to which it has no right. New York State recently has had an example of this. Summer residents of the Adirondack Mountains have raised a row that has gone all the way up to the governor over the drawing down of Indian Lake and the Sacandaga Reservoir, both artificial reservoirs maintained for the express purpose of supplementing low flows in the Hudson River in case of drought. The Sacandaga Reservoir—owned by a public body, the Hudson River Regulating District—was formed only recently, yet those who use it for pleasure purposes appear to have forgotten that the power and paper companies on the Hudson River agreed to reimburse the state for the cost of building and maintaining it in order that they might be able to draw it down during the summer months. Here is an opportunity for the daily press, and probably for public service commissions, to correct the uninformed views of summer campers by a full statement of facts of each case. The inconvenience to the campers, we are confident, in most cases will be found to be insignificant as compared to the benefit to the community generally through the continuing employment that the reservoir water provides and the improvement that the added water makes in sanitary conditions along the streams into which the water flows.

Codes and Public Works

CODE PROGRESS during these days is almost tumultuous in its rapidity. The past week's major accomplishments of completing codes for oil, lumber and steel aside from a host of lesser industries, and tentatively promulgating a construction code, constitute a remarkable demonstration of driving progress and enthusiastic cooperation of industry groups in the spirit of the Recovery Act.

If these facts justify much hope, there is even greater hope in the beginnings of planned control of production and price structure, as represented particularly by the lumber and oil codes. The natural-resource industries have achieved a determined approach to stabilization; the non-resource industries may in due time succeed in corresponding stabilization. Thus, the self-government of industry and business that seemed a distant dream only two months ago is beginning to emerge into reality.

Whether the conflicting requirements of expanded purchasing power and of business solvency and profits will find early adjustment still remains to be learned. It is reported that prices are rising faster than wages and thus are reducing individual purchasing power. At the same time many business groups face the question whether they can carry the increased expense due to NRA codes out of their resources and income. In many quarters the question already is at a critical point. Greater volume of industry and commerce contains the answer to these doubts.

It is the purpose of the industry-control program that employment shall be expanded rather than merely diluted. For the moment all subscribers to codes are giving this purpose whole-hearted support, but it is clear that they can do so only while their resources suffice to support the increase in operating cost—or until their volume is increased sufficiently to cover this cost. Unless the economic cycle by which wages become redistributed in the form of increased consumption reaches each industrial and business group very soon, the system has within it the seed of collapse. The gravity of such an outcome hardly needs emphasis.

For this obvious and compelling reason the recovery program was made to rest essentially on the new purchasing power that would result from construction of the abandoned and deferred public-works operations of the last three years. The Recovery Act therefore provided loan and grant funds for local works, as well as for an increased amount of federal construction, in the total sum of $3,300,000,000. Several million man-years of work were thus made possible. The intent was that they should be drawn upon with the greatest possible speed, and that they should be utilized this year and next as fully as physical needs and the demands of recovery might dictate.

What has been accomplished with this very essential instrument of recovery since June? The hard fact is that virtually nothing has been accomplished.

The contrast with the achievements of the industry-control administration is startling. The two horses of the team provided by Congress to draw the business cart out of the mire have pulled quite unequally; one has worked powerfully and with courage, the other has been a laggard. General Johnson's organization has not only inspired the nation and electrified business and industry with a new spirit, but at last count had put 1½ million men back to work. The Public Works Administration has re-employed scarcely a few thousand. It has authorized federal projects almost exclusively, many of them of long-range kind that cannot produce employment for months to come. Municipal projects, the greatest reservoir of work that we have, were forced to mark time, and weeks more are likely to pass before they can go ahead. Worse yet, there is little left of the active energy and enthusiasm that existed in state and city organizations last June. The spirit of quick and hearty cooperation on which the success of any such great undertaking as that of the Public Works Adminstration depends has been destroyed.

This in a word is the record of a movement that was planned to bring about emergency re-employment—employment not next spring but now, this summer, this fall and winter—in order to put a final end to the distress and disintegration that were at a peak early this year. True, the movement has been hampered by politics, by official intrigue, by contest for personal advantage and patronage, as well as by little-concealed hostility in some government circles to public-works construction, especially of the local government units. But these factors, though they explain what has been happening, cannot excuse failure, for failure of the public-works program means failure of the recovery program as a whole.

The obstacles can yet be removed and rapid progress assured. Projects of states and cities are ready to go in large numbers, and the will to make them an immediate factor in economic recovery is alive and active in the local authorities. They are looking for determined action by the administration, and they know that effective action is possible. Bureaucracy can be eliminated, political and departmental intrigue can be checked, and all elements of the administration can be marshalled in support of the great objective. But unless such action is taken in time, it will be of little value. The season available for beginning large-volume construction is waning rapidly, and if it is wasted another winter it may be darkened by the evil results of unemployment.

NEWS OF THE WEEK

Engineers' Code Nears Final Form Under Close Study

OUT of the many tentative drafts of a code for engineers in the construction industry under the National Industrial Recovery Act there is developing a code that is expected to be in satisfactory form for presentation to the code committee of the Construction League early next week.

Preparation of this code, as noted previously (*ENR*, Aug. 3, p. 146 and Aug. 10, p. 180), is being carried forward under the leadership of the American Society of Civil Engineers, Carlton Proctor being chairman of the society's committee. Following the two-day meeting of representatives of several engineering societies noted in our issue of Aug. 10, copies of the code drafted at that meeting were taken to Chicago by George T. Seabury, secretary of the society and to San Francisco and to Los Angeles by Mr. Proctor where it was discussed and changes suggested to make it adaptable to the needs of those regions. Copies of the code also were sent to the twenty organizations asked to participate in the Aug. 2 meeting.

All recommended changes were considered at a meeting held in New York on Aug. 21 and the modifications of the draft code decided upon at that meeting are now being incorporated in a new draft for consideration of the executive committee of the Am. Soc. C. E. on Aug. 25.

Professional fees

The matter of fees for professional services, referred to a small committee under the chairmanship of Harrison P. Eddy, is one of the most difficult problems involved in the code drafting. The fee committee has prepared a schedule of fees which it was first proposed to incorporate in the code and copies of it have been circulated to representative engineers throughout the country for comment. Views expressed upon it have been so diverse, chiefly because it makes no provision for wide regional variations, that it is expected now that no attempt will be made to cover fees in the code as specifically as first proposed.

Wage rates

The code classifies as professional engineers all engineers who are members or eligible to membership in engineering societies requiring for membership active practice of not less than seven years and one year of responsible charge of work. All other engineering employees are classified as engineering assistants. The original draft set up minimum wage rates and maximum hours for these men but made no similar provision for the higher grade of employees who fell into the classification of professional engineers on the ground that they were professional men and as such excluded under a ruling of the NRA excluding professional men from the provisions of the Recovery Act. Now, however, it is expected that provision will be made in the code for regional wage adjustments through sub-committees of the national control committee to be set up under the code as it is recognized that the intermediate grades of engineers in large organizations or in the employ of large city departments should have the right for collective bargaining.

On Federal Contracts No Price Changes Possible

Comptroller General McCarl has made an informal ruling that existing contracts with the federal government cannot be changed in recognition of the increased prices caused by compliance with NRA codes. According to the ruling, Congressional action would be necessary for any such changes to be valid.

Ship Rams Construction Trestle To Golden Gate Bridge Pier

During a heavy fog a freighter wrecked several bents of the trestle which provides access to construction operations on the south pier of the Golden Gate bridge. The damage amounted to several thousand dollars and the reconstruction will temporarily delay construction work although the general progress on the project will be noticeably interrupted.

The channel width between the piers is 4,200 ft. and the ship was well outside this lane and within a few hundred feet of the rocks on the San Francisco side of the gate. The accident is blamed on a thick fog and an unusual current. The trestle and its function was described in the recent progress article on the project in our issue of July 6, 1933, p. 7.

Minimum Wage Rates Set For Public Works Fund Projects

MINIMUM-WAGE rates on construction projects undertaken through the assistance of the federal public works funds have been approved in a resolution recently passed by the Public Works Board. The rates were under an agreement signed by representatives of the American Federation of Labor, arranged by the United States Department of Labor. Under the resolution the country is divided into three wage zones: Southern, Central and Northern. It is specified that the rates are to be effective for public works fund construction for a period not to exceed 12 months.

The Labor Wage Board, consisting of Henry W. Blumberg, Carpenters Union; Charles L. Reed, Electrical Workers Union; John Colfield, Plumbers Union; Thomas A. Lane, Bricklayers Union, and M. J. McDonough, signed the agreement. Mr. McDonough is chairman of the Building Trades Council of the American Federation of Labor.

The agreement in resolution form as adopted by the Special Board for Public Works is as follows:

"I. Be it resolved that, for the purpose of determining wage rates on all construction financed from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act, the United States shall be divided into three zones as follows:

Southern Zone: South Carolina, Georgia, Florida, Arkansas, Alabama, Mississippi, Louisiana, Arizona, Oklahoma, Texas and New Mexico.

Central Zone: Delaware, Maryland, Virginia, Tennessee, Colorado, Utah, California, North Carolina, West Virginia, Kentucky, Missouri, Kansas, Nevada and District of Columbia.

Northern Zone: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Indiana, Wisconsin, Minnesota, Nebraska, Wyoming, Oregon, South Dakota, Idaho, Pennsylvania, Ohio, Michigan, Illinois, Iowa, North Dakota, Montana, Washington.

The hourly wage rates to be paid on construction projects in these zones shall not be less than the following:

Southern Zone: skilled labor, $1.00; unskilled labor, 40 cents.

Central Zone: skilled labor, $1.10; unskilled labor, 45 cents.

Northern Zone: skilled labor, $1.20; unskilled labor, 50 cents.

"II. Be it further resolved, that in the event that the prevailing hourly rate prescribed under collective agreements or understandings between organized labor and employers on April 30, 1933, shall be above the minimum set for any district within that zone; that agreed wage rate shall be the rate to be paid for employees on construction projects financed from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act.

"III. Be it further resolved, that the rates specified in paragraphs I and II shall be effective during the life of any contract financed from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act, but for a period not to exceed 12 months.

"IV. Be it further resolved, that the above designated minimum rates are not to be used in discriminating against assistants, helpers, apprentices and serving laborers who work with and serve skilled journeymen mechanics and who are *not* to be termed as 'unskilled laborers.'

"V. Be it further resolved, that there shall be created a Board of Labor Review which shall hear all issues arising under the operation of all contracts financed

from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act and from such problems as may result from fundamental changes in economic conditions during the life of these contracts. The Board of Labor Review to be created shall consist of three members; one to represent labor; one to represent contractors and a Chairman who shall represent the Federal Emergency Administrator of Public Works. The members of this Board shall be appointed by the President of the United States but no member shall be connected in any way with any organization of building workers or directly connected with, or have any interest in, contracting. The Chairman shall not be in any way connected with the Federal Emergency Administration of Public Works. Decisions of the Board of Labor Review shall be binding upon all parties."

Plan Island Airport For Chicago Lake Front

A $6,000,000 island airport on the Chicago lake front has been designed by the Chicago Plan Commission and money with which to build it is being sought from the federal government on the basis of an outright grant under the National Industrial Recovery Act.

The project is to be located in the Chicago Harbor District 2, off Grant Park, east of the Adler planetarium to which it would be connected by a 500-ft. bridge. It is triangular in shape with the apex in deep water, which will reduce the filling. Runways, 2,800 ft. long in six directions will be provided. A hangar, terminal building and shops costing $500,000 is expected to be muilt by the air line companies.

Air mail now landed at the Chicago Municipal Airport at 63rd and Cicero Ave. takes an hour to get to the post office. The new location would reduce the time to 10 minutes and the cost by $40,000 per year.

Boston Likely to Build New Back Bay Subway

Directors of the Boston Elevated Railway voted on Aug. 10 to accept a 1933 enactment of the Massachusetts legislature, providing for the construction of a subway for surface cars under Huntington Avenue from Copley Square to Longwood Avenue. The estimated cost of the work is $8,500,000, and the Boston Transit Department will do the work, if approved by the necessary state and federal authorities under the National Recovery Act. It is planned to handle the job by day labor as was done in the recently completed Kenmore extension of the Boylston Street subway. The subway would result in clearing the street surface of trolley cars in this section of the Back Bay, and would reduce the running time between the Art Museum and Symphony Hall districts and downtown by several minutes. Special features would be an underground crossing of the Boston & Albany Railroad west of Trinity Place station and a station at the intersection of Huntington and Massachusetts Avenues. Col. Thos. F. Sullivan is chairman of the Transit Department, which has been studying plans for this work for some time.

PWA Grants Loans To Triborough Bridge and Housing Projects

THE FIRST large municipal public works project to receive the approval of the Federal Public Works Administration made a grant and a loan to the Triborough Bridge Authority of New York City to complete the construction of the Triborough Bridge connecting the Boroughs of Manhattan, Bronx and Queens.

The Authority was made a grant of $7,200,000 and was extended a loan of $37,000,000 to be repaid with 4 per cent interest within 20 years. The loan was advanced against bonds issued by the bridge authority which constitute a first lien against revenue to be derived from the bridge.

As a great deal of work has already been done by the City of New York, there will be no delay in resuming operations on a large scale. In anticipation of approval of application for a loan, the Authority has had an engineering force of more than 40 men engaged for several weeks in preparing contract plans and the Authority is ready to proceed at once with contracts calling for an expenditure of $4,300,000. It is expected that within 60 days other contracts will be awarded resulting in the expenditure of $4,100,000.

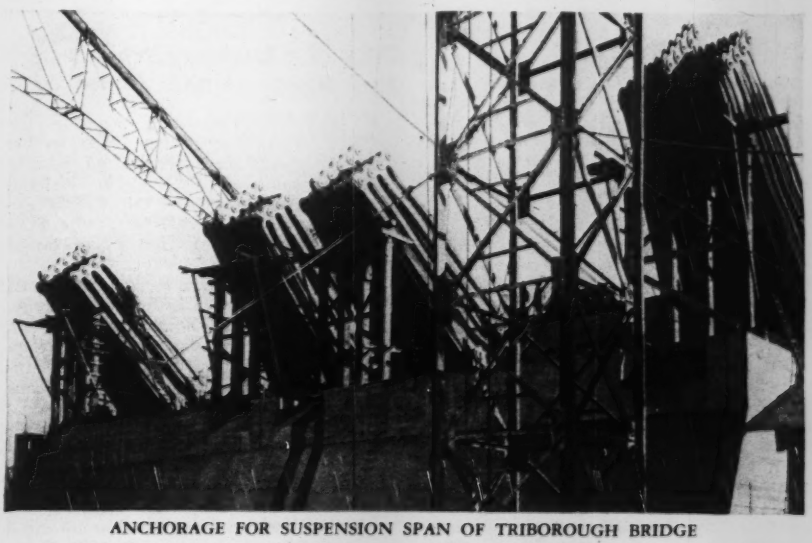
The bridge, connecting the three boroughs, really is four bridges in one. It passes over the Harlem River, Bronx Kills, Hell Gate and Little Hell Gate. The total length will be 17,710 feet. It consists of a suspension bridge, through truss bridge, a vertical lift bridge, a steel arch bridge and various types of connecting viaducts. The main bridge from the Bronx to Queens will be more than two miles in length.

To date New York City has spent $5,307,000 on the project, $3,225,000 for construction and $2,082,000 for the purchase of property.

The Government's grant and loan is subject to agreement between the Administration and the bridge authority on a contract securing the Government's investment and requiring that all policies announced by the Public Works Administration be fulfilled.

At the same time announcement was made by the P. W. A. of the approval of a loan for five model housing projects aggregating $9,620,000. A loan of $3,500,000 to Neptune Gardens, Inc., in Boston, will provide for the construction of a project to be built on 44 acres of land adjoining Marine Memorial Park. The Spence Estate Housing Corporation had its application for a loan of $2,025,000 tentatively approved for a housing project in Brooklyn. This is the first real slum clearance project to be acted upon by the P. W. A. The proposed project will consist of a six story elevator building with 508 apartments, of semi-fireproof construction. A loan of $845,000 to a limited dividend corporation formed by officers and members of the American Federation of Full-Fashioned Hosiery Workers in Philadelphia was given tentative approval. The housing in this case will consist of three-story semi-fireproof buildings, containing 292 apartments, the site covering an area of 4½ acres in the Kensington district of Philadelphia. The Dick-Meyer Corporation was granted a loan of $3,210,000 for a model housing project in the borough of Queens, New York City. This project is to be built under the New York State Housing Law, and will consist of ten six-story semi-fireproof elevator apartments. The fifth housing project to be given tentative approval was the Hutchinson (Kansas), Suburban Housing Association, which was granted a loan of $40,000. This project will provide 20 individual four room and five room houses, each situated on two acres of land.

On August 22, an allotment of $1,759,500 was made for sewerage work in the District of Columbia, $3,500 to the Bureau of Entomology and $1,200 to the Bureau of Home Economics for building reconditioning and equipment.



ANCHORAGE FOR SUSPENSION SPAN OF TRIBOROUGH BRIDGE

The federal public works authority has recently announced tentative approval of a loan of $37,000,000 and a grant of $7,200,000 for the completion of the Triborough bridge in New York City, connecting the boroughs of Manhattan, Bronx and Queens. The bridge crosses the Harlem River, Bronx Kills, Hell Gate and Little Hell Gate. The principal span, across Hell Gate, connecting Manhattan and Queens, will be of the suspension type, with a span of 1,380 ft. The illustration shows the anchorage for this span when construction was discontinued because of lack of funds.

Metropolitan Sewerage District Planned for Niagara Region

A committee will be appointed by mayors of cities in the Niagara Metropolitan Sewerage District, comprising Buffalo, Niagara Falls, Lockport, Tonawanda and Lackawanna, N. Y., to study and report on a sewerage district plan which proposes construction of a $30,000,000 sewage and disposal system to end pollution of Lake Erie and the Niagara river. The report of Edward P. Lupfer, prominent civil engineer, will be studied particularly. Governor Lehman will be requested to secure authority for the creation of a commission for this project from the legislature, now in special session. It is proposed to finance the undertaking by a bond sale by the commission so that the debt limit of the municipalities will not be affected. It is hoped to sell bonds to the Federal government under the public works provisions of the NRA so that 30 percent of the cost could be met by direct federal grants.

No Change of Site Planned For Cove Creek Dam

Immediate preparation of preliminary plans for a tie-transmission line between Wilson Dam at Muscle Shoals and the Cove Creek site has been ordered by the Tennessee Valley Authority. The distance between the two points is approximately 220 miles. Preparation of the plans will be directed by Llewellyn Evans, consulting engineer, now at Muscle Shoals.

The board also authorized immediate action to provide power for Florence, Sheffield and Tuscumbia, Ala., in the immediate vicinity of Muscle Shoals. Negotiations with these towns will be undertaken by Mr. Evans immediately and follow a report made to the board by David E. Lilienthal, who inspected the government's power facilities at Muscle Shoals, and received the applications for service from the town officials.

Cove Creek Dam will be built on substantially the same location selected by the Army Corps of Engineers, according to the Tennessee Valley Authority and unless studies made in the next few weeks warrant otherwise, the dam will be of the gravity concrete type recommended by the Army. The board will take over the services of approximately 200 men comprising the engineer corps in the Cove creek area.

An announcement states that the dam will be built on force account but there still seems to be some uncertainty about this. The reasons given by the Tennessee Valley Authority for using its own forces, follow:

1. The plans will not be finished for about six months. It would be difficult to take bids until the plans are completed, but it is possible to begin work very soon by using the Authority's own labor, doing those things which will not conflict with plans as they develop. In this way about six months can be saved.

2. It may be necessary to change substantially the foundation plans when the excavation for the foundation has exposed the nature of the underlying rock. If the Authority is doing the work with its own forces these changes can be made more readily.

3. It is the intention of the Authority to employ about twice as many men as would otherwise be required on the Cove Creek dam, its first major project, working them three days a week and maintaining a training program for them the other three days. To carry through this program the Authority must select the workmen. It could not do this if the work were let by contract. The whole training program depends on the direct handling of the work by the Authority. Local unemployed will be utilized as far as possible.

4. Mr. John L. Savage, who has been loaned by the Reclamation Bureau of the Interior Department to review the design for the Cove Creek dam, strongly recommends that its construction be by the Authority's own forces. Mr. Savage, prominent in designing Boulder and other large dams, believes that the best and most economical results will come from the direct responsibility of the Authority's own construction superintendent, without the intervention of a contractor.

5. The Authority has available a very able construction superintendent who has handled large work in the United States, and also remote regions, where he has had to carry all the responsibilities and relations of the contractor. By selecting its own construction superintendent the Authority gets the same service as though that man were employed by a contractor, besides availing itself of the type of man best suited to the important task.

In order to carry out the training program and provide permanent homes for a number of people, one or more towns are planned in the vicinity of the dam. As a rule, each house will be provided with from one to five acres of tillable land, though not necessarily adjacent to it.

The Authority will proceed at once to acquire land in the vicinity of the dam, and in the Cove Creek reservoir. It will take up, as soon as possible, the re-location of roads and railroads in the more than 80 square miles of area to be inundated. Meanwhile it is plotting a road to the dam site and deciding whether or not to build a rail connection to the dam.

Fifty-Five Highway Projects In National Forests Approved

A highway construction program for national forests has been announced by the United States Forest Service, to go into effect immediately. The program includes 55 projects in 9 states and calls for the expenditure of about $5,000,000 of the $15,000,000 of public works funds apportioned for national forest highways.

Projects approved are located in national forests in Arizona, California, Colorado, Idaho, New Mexico, South Dakota, Utah, Washington, and Wyoming. Location surveys in most of these states are also included in the estimates of cost. Programs for other states containing national forests, and additional programs for the states already named will be approved as soon as recommendations of the state highway commissions, the Forest Service, and the Bureau of Public Roads are received.

The construction program now approved involves the expenditure of $330,000 in Arizona, $746,000 in California, $437,000 in Colorado, $556,000 in Idaho, $210,000 in New Mexico, $45,000 in South Dakota, $190,000 in Utah, $820,000 in Washington, and $286,000 in Wyoming.

Quebec to Build Dam to Improve Water Supply

The city of Quebec has given formal notice of its intention to build a big dam at Lake St. Charles, for the purpose of storing at all seasons the waters of the lake, with the object of conserving them so as to regulate their flow, and thus to ensure a uniform supply for its waterworks system. Plans and specifications showing the site and nature of the work and the land which will be affected by it, have been filed with the Quebec Government.

Improvement District in Texas Gets R.F.C. Loan

Tarrant County Water Control and Improvement District No. 1, in the state of Texas has received the sum of $450,000 as a loan from the Reconstruction Finance Corporation. The money will be applied as follows: Deposit in condemnation proceedings involving Rock Island right-of-way in the Bridgeport basin, $257,000; filling gap in the levee, $31,000; valve gates at the Eagle Mountain site, $10,000; engineering, legal and miscellaneous, $45,000, and engineering estimates Eagle Mountain, $102,000.

California Registration Law Amended to Increase Fees

Two amendments to the law requiring the registration of civil engineers in California were passed at the recent legislative session modifying the original act which was approved in 1929.

One amendment requires that an application for permission to use the title "structural engineer," a classification established by a 1931 amendment, must be accompanied by a fee of $10 which is to be retained by the board. Under the original amendment setting up this sub-classification no fee was required. The other amendment provides that, "the board may, upon application therefor, and the payment of $10, to be retained by the board, issue a certificate of registration as a civil engineer to any person who holds a certificate of qualification or registration issued to him by proper authority of the National Council of State Boards of Engineering Examiners, or of the National Bureau of Engineering Registration, or of any State, Territory or Possession of the United States, or any country, provided that the requirements for the registration of civil engineers under which said certificate of qualification or registration was issued do not conflict with the provisions of this act and are of a standard not lower than specified in section 7 of this act."

Under the original act the renewal of the certificate of registration is required each year before the 30th of June with the payment of an accompanying fee of $5. A new amendment declares that, "after the thirtieth day of June each year the application for reinstatement of an expired certificate of registration must be accompanied by one dollar for each calendar month or fraction thereof applicant is delinquent after June 30th, until the amount aggregates the sum of $5 as a penalty for delinquency, in addition to the annual renewal fee of $5."

Allotments from PWA Fund Total $1,198,485,589

MORE than one-third of the $3,300,000,000 public works fund has already been allotted, it has been announced by the Public Works Administration. Allocations made to date total $1,198,485,589.

The following table shows allotments from the public works fund to date:

Farm Credit Administration (statutory)	$100,000,000
Tennessee Valley Authority (statutory)	50,000,000
Highways (Agriculture) (statutory)	400,000,000
Naval Construction (Executive order)	238,000,000
Public Works Administration, administrative	100,000
National Recovery Administration, administrative	630,000
Civilian Conservation Corps (Executive order)	20,000,000
Civilian Conservation Corps (Executive order)	20,000,000
National Arboretum (Executive order)	171,638
Great Smoky National Park (Executive order)	1,550,000
Subsistence Homesteads (statutory)	25,000,000
Federal Power Commission	400,000
Re-employment Service, Department of Labor	500,000
Department of Agriculture, departmental	340,800
Agricultural Engineering	77,813
Animal Industry	549,240
Chemistry and Soils	33,919
Chemistry and Soils and Engineering	57,750
Dairy Industry	173,670
Entomology	15,150
Experiment Stations	4,950
Food and Drug Administration	70,000
Forest Highways	15,000,000
Forest Roads and Trails	10,000,000
Plant Industry	648,807
Plant Industry (erosion control nurseries)	630,000
Forest Service (physical improvements)	15,982,745
Plant Industry	2,830,000
Plant Quarantine	2,020,620
Plant Quarantine	58,050
Public Land Roads	5,000,000
Weather Bureau	20,000
Agricultural Engineering (soil erosion control)	5,000,000
Commerce Department, Coast and Geodetic Survey	2,600,000
Aeronautics	443,000
Fisheries	150,000
Fisheries (five stations)	150,000
Lighthouses	5,225,202
Navigation	30,000
Standards	100,000
Interior Department:	
Alaskan Railroad	210,008
Alaska Road Commission	1,096,000
Columbia Institution for the Deaf	10,000
Freedmen's Hospital	85,000
Geological Survey (physical improvements)	1,200,000
Geological Survey (Surveys)	2,500,000
Howard University	948,811
Indian Affairs (physical improvements)	2,820,000
Indian Reservation Roads	4,000,000
National Park Service (physical improvements)	1,250,000
Roads and Trails	16,000,000
Reclamation	44,460,000
Boulder Canyon $28,000,000	
Machinery 10,000,000	
Owyhee 5,000,000	
Yale 1,000,000	
Ellensburg 60,000	
Ronald 400,000	
Reclamation, Casper-Alcova	22,700,000
Grand Coulee, Columbia Basin	63,000,000
St. Elizabeths Hospital	850,000
Virgin Islands	114,500
Additional National Park Service	6,000
Bureau of Reclamation	20,000
Department of Justice (construction)	851,000
Department of Labor, Immigration	1,344,480
Post Office (departmental)	7,600
State Department, International Commission	26,500
State Department, International Commission (US-Mexico)	1,501,500
Treasury Department, Public Health Service	102,438
U. S. Marine Hospital, Staten Island	2,272,051
Supervising Architect (Public Buildings)	6,971,648
Supervising Architect (Public Bulidings)	11,527,499
War Department, Flood Control	1,555,000
Ordnance	6,000,000
Flood Control	7,000,000
Rivers and Harbors (Upper Mississippi)	11,500,000
Corps of Engineers (seacoast defenses)	6,000,000
Rivers and Harbors	8,000
Independent Offices, Arlington Bridge Commission	200,000
National Advisory Committee for Aeronautics	200,000
Panama Canal	1,000,000
Housing Projects:	
Neptune Gardens, Inc., Boston	3,500,000
Spence Estate Housing Corporation, Brooklyn	2,025,000
American Federation of Full-Fashioned Hosiery Workers, Philadelphia	845,000
Dick-Meyer Corporation, New York	3,210,000
Suburban Housing Association, Hutchinson, Kansas	40,000
Triborough Bridge Authority, New York (Loan $37,000,000; grant $7,200,000)	44,200,000
District of Columbia (sewerage improvements)	1,759,500
Bureau of Entomology	3,500
Bureau of Home Economies	1,200
Total	$1,198,485,589

Port District Proposed For Wayne Co., Mich.

A step leading to the establishment of a port district in Wayne County, Mich., in connection with the St. Lawrence Waterway project has been taken by the supervisors of Wayne County in appropriating $2,500 for preliminary surveys. The establishment of such a port district will require a favorable vote in the county. If the project is approved by the electors, it is planned to apply for federal funds to finance harbor improvements under the National Recovery Act.

Arthur S. Tuttle Named Engineer For PWA Work in New York

Arthur S. Tuttle, consulting engineer, New York, retired consulting engineer to the Board of Estimate and Apportionment of the city of New York, has been appointed state engineer for the Federal Emergency Administration of Public Works for the state of New York, according to an announcement made by the Administrator on Aug. 22. Appointment of Mr. Tuttle completes the list of state engineers for the PWA. Appointments for the other states were announced last week (*ENR*, Aug. 17, p. 208). It is expected, however, that some changes will be made in the list as then announced as some of the engineers named have signified that they will be unable to accept the appointment.

Mr. Tuttle, in recent months, has been serving as one of the committee of five named by the mayor of New York to administer unemployment relief work; he also has been serving as consulting engineer to the Citizens Budget Committee. At the time of his retirement in February of this year he had been in the city service almost continually over a period of 48 years.

Washington Notes

By Paul Wooton
Washington Correspondent

Because of its effect on the private construction industry and ultimately upon the market for construction, the minimum wage agreement entered into by the Public Works Board with the organized building trades union has a significance far beyond its effect on the public works program.

The Building Trades Department of the American Federation of Labor has not yet revealed whether it will insist that the minimum rates paid on construction financed by public works funds be written into the construction industry's code but M. J. McDonough, president of the Building Trades Council of A. F. of L. states that "we anticipate no worse condition from private contractors than we would from the government."

That the Public Works Administration hopes the rates established will have widespread application is evident in Secretary Ickes' statement that "the wage rates determined for building construction should bring about a stabilized condition in the construction industry."

The wage schedule adopted by the Public Works Board fixes the minimum rates for both, but does not define what constitutes either skilled or unskilled labor. It is understood that the board deliberately avoided any attempt at definition. This would seem to indicate the desirability of including in the contractors' code drafted by the Construction League a definition of skilled labor. That code refers only to white collar labor and unskilled labor, and fixes the minimum rate of the latter at 40c. per hour.

It is still an officially open question whether the minimum rates specified by the Public Works Board will apply to road contracts, but the decision probably will be that state highway departments may elect to adopt such rates but will not be required to do so. The National Industrial Recovery Act specifically provides that the state highway departments fix pre-determined minimum rates for skilled and unskilled labor on road work.

Allotments by the Public Works Administration now run into a large figure, $1,198,485,589, but practically no money has been converted into jobs to date. Most of the big federal projects on which the Ickes board concentrated at first necessarily require time to get under way. The close check on the $400,000,000 road program has delayed advertisement of bids; 67 contracts had been awarded to Aug. 21 and 465 projects have been specifically approved but these account for only $32,368,453, or 8 per cent of the total available.

The organization set up for handling selection of local projects is still stiff and persistent reports of continued friction between Secretary Ickes and Budget Director Douglas on allotment of funds for local projects must be given some credence. Publicity from the Public Works Administration has been mostly ballyhoo; practically the entire construction program is still on paper today. There are several legitimate reasons for deliberation but protests against the delay are pouring into Washington as the end of the construction season approaches in northern states.

State engineers and advisory boards are reported to be studying hundreds of projects with a view to speeding their recommenda-

tions to Washington. Secretary Ickes promised this week that many non-federal projects now under consideration by the Administration will be approved soon. But the reasons must be stated. The legal and engineering divisions may, for example, approve a project but the financial division may reject it because the municipality could not offer proper security for a loan or show that efforts are being made to bring expenditures within prudently estimated revenues. After all divisions give preliminary approval the project is subjected to a more intensive study to clear up any challenges and if it qualifies the project is then submitted to the Administrator and the Public Works Board for final action.

River and harbor work

Col. Henry M. Waite announced August 22 that he would submit for the consideration of the board on August 24 quite an extensive program of river and harbor improvements and Mississippi flood control work. Col. Waite said that he had not taken up with Budget Director Douglas the question of releasing impounded appropriations for rivers and harbors.

The Public Works Administration had received 21 local projects from 9 states up to August 22. These projects had the approval of the state engineers and state advisory boards, but in some cases the Public Works Administration is calling for additional information. All local projects received from the field are sent simultaneously to the legal, financial and engineering divisions at headquarters. These divisions are required to make a quick preliminary survey to determine whether the project is within the scope of the law and whether all required information has been furnished.

A project can be disqualified by any of these divisions.

The Public Works Board has requested from Henry T. Hunt, counsel, an opinion whether a 30-year basis of amortization can be applied to reclamation projects, such as Casper-Alcova, financed by public works funds. This is the rule that has been applied to non-federal projects, but the existing law on reclamation projects fixes the amortization period at 40 years.

Emil Hurja has been appointed by Secretary Ickes as administrative assistant on public works. Mr. Hurja has served Postmaster General Farley as lieutenant on patronage matters in several departments but Secretary Ickes stated in announcing the appointment that he would continue to be his own personnel officer.

Louisiana Contractors Take Bonds for their Warrants

Contractors, material firms, and railroads holding warrants or so-called certificates of indebtedness of the Louisiana Highway Commission, have accepted a proposal to pool their interests in the purchase of $7,500,000 in state highway bonds, two-thirds of which may be pledged with the R.F.C. for loans. The obligations of the commission covered by the proposal are the remnants of the 1931 paving contracts, which were entered into with the expectation of the commission selling its bonds. This was subsequently rendered impossible by the collapse of the bond market.

Of the total obligations, $1,500,000 is due the city of New Orleans, $1,425,000 due the railroads for hauling materials and $4,575,000 due contractors.

Washington Governor Approves Ship Canal Project

The Puget Sound to Columbia River Ship canal project, estimated to cost $33,000,000, has been given the full approval of Governor Clarence D. Martin of Washington. The governor had originally recommended immediate construction of only the two smaller canals, but has now approved the entire project.

California Water Plan Ready for PWA Financing

Financing of the $160,000,000 California state water development program can be placed before the PWA as the result of recent legislative action. A new law provides for the issuance of revenue bonds to finance the project and the Authority, also established by the act, has taken preliminary steps to place the plan before the local federal officials. The principal remaining question will be the repayment requirement which will be imposed by the PWA for the security of the revenue bonds. Hydro-electric power output forms the principal source of revenue.

Passed after considerable legislative controversy, the new enabling act establishes a State Water Project Authority, consisting of five state officials, provides for the issuance of revenue bonds, provides for federal cooperation, legalizes the preferential of state over individual water rights, and authorizes the Authority to establish rates and charges for disposing of the project's resources.

This statewide water development project has been under study for many years as the ultimate solution of the state's water supply problems. Engineering plans, except for details, have been completed for several years and legal and economic questions have provided the principal problem delaying legislative action. The most pressing need has been for the relief of established irrigated areas with deficient water supply and this phase provides the minimum financing possibility. On the other hand, the principal revenue—hydro-electric power—has been, and is, highly problematical because of the present surplus. Minor features are the regulation of floods and the improvement of navigation in the Sacramento River and upper San Francisco Bay regions. The U. S. Engineers have already reviewed the navigation benefits and recommended a direct federal appropriation for this phase of the project.

The PWA provided a financing possibility which the legislature accepted after declining to attempt direct state financing. The enabling act provides for the issuance of revenue bonds against the project's resources for the financing of construction.

The project is a combined irrigation, flood control, navigation and power development based on a comprehensive study of the ultimate water resources and requirements of the state. The largest single unit is the proposed Kennett Dam and power development on the upper Sacramento River which has an estimated total cost of about $80,000,000. This reservoir, storing almost 3,000,000 acre-ft., will regulate the flow of the stream, reduce floods, improve navigation and reduce the serious encroachment of salt water in the rich agricultural areas of the delta. The other storage feature, the Friant Dam in the upper San Joaquin Valley, will provide storage to relieve serious irrigation deficiencies on several hundred thousand acres of land now under development. The lower San Joaquin Valley irrigation problem will be solved by delivering excess Sacramento Valley water upstream in a series of pumping lifts.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual meeting, Chicago, Ill., Oct. 3-6, 1933.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Milwaukee, Wis., Oct. 9-11.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Chicago, Oct. 17-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Indianapolis, Ind., Oct. 9-12.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Milwaukee, Wis., Sept. 25-27.

AMERICAN WELDING SOCIETY, fall meeting, Detroit, Mich., Oct. 2-6.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, annual meeting, Milwaukee, Wis., Sept. 21-23.

INTERNATIONAL CITY MANAGERS ASSOCIATION, annual conference. International House, Chicago, Sept. 18-20.

NATIONAL SAFETY COUNCIL, 22nd Annual Safety Congress, Chicago, Oct. 2-6.

NATIONAL ASSOCIATION OF RAILWAY AND UTILITIES COMMISSIONERS, annual meeting, Cincinnati, Ohio, Oct. 10-12.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Bridgeport, Conn., Sept. 19-22.

MISSOURI WATER AND SEWERAGE CONFERENCE will hold its ninth annual meeting at Jefferson City, Mo., on Sept. 22 and 23. The meetings will be held in the state capitol building. The Missouri Public Health Association also is meeting in Jefferson City on these dates, and one session will be devoted to a joint meeting of the two organizations.

PENNSYLVANIA SEWAGE WORKS ASSOCIATION and the PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION will hold their annual conferences at State College, Pa., Sept. 5 to 9. The Sewage Works meeting will be held on Tuesday, Wednesday and Thursday morning; the Water Works meeting will be held on Thursday morning and Friday and Saturday.

MICHIGAN CONFERENCE ON WATER PURIFICATION will hold a joint meeting with the CENTRAL STATES SECTION of the American Water Works Association at Grand Rapids, Sept. 19 to 22.

Obituary

JULIUS H. POTTER, 42 years of age, connected with the Buffalo Slag Co., Buffalo, N. Y., and well known in building and engineering circles in Western New York, died August 14, after a short illness.

CHESTER F. MICHAELS, state highway supervisor of maintenance for Pacific and Western Wahkiakum Counties at Raymond, Wash., for the past six years, died in that city recently at the age of 47 years.

JOHN CREIGHTON BAXTER, president Carey, Baxter & Kennedy, Inc., contractors and engineers, died in New York City on July 27. Death resulted from injuries received in a traffic accident. He was 55 years old.

HARRY WRIGHT HENDERSON, 44, civil engineer and bridge designer of Hammond, N. Y., died at the House of the

Good Shepherd, Watertown, N. Y., August 4, after a short illness. He was a Clarkson College graduate, class of 1911.

WILLIAM H. HALL, president of W. H. Hall Construction Co. of Hartford, Conn., paving contractors, and city engineer of New Britain, 1914-1920, died at his home in West Hartford, Conn., Aug. 14, at the age of 52 years.

JOHN F. AMOS, 58, chief engineer and chemist for the Rochester and Lake Ontario Water Co., died at his home in Charlotte, N. Y., a Rochester suburb, on August 16. His death came unexpectedly. Mr. Amos was born in Faxton, Pa., and came to Rochester when the water works was formed in 1904.

WILLIAM RICKETSON HOAG, consulting engineer of Lake Worth, Fla., died of heart disease while on a visit at Minneapolis, Minn., on Aug. 11. He was 74 years old. Mr. Hoag was head of the civil engineering department of the University of Minnesota until the time of his retirement in 1905.

W. DABNEY HUNTER, formerly superintendent of public works at Melrose, Mass., died in that city on Aug. 15. He was born in New London, Va., in 1863 and during his incumbency at Melrose from 1900 to 1907 supervised the construction of the water and sewerage systems. Since leaving the city's service he had been engaged in private business until his retirement about a year ago.

ARTHUR TAPPAN NORTH, architect, former engineering editor of the *American Architect*, died on Aug. 15 at his home in New York City. He was 69 years old. In January he suffered a leg fracture when struck by an automobile and had never recovered from the shock. For several years Mr. North was director of industrial relations for the American Institute of Steel Construction.

GEORGE M. RICE, consulting engineer of Seattle, Wash., died of heart failure while on a camping trip on Aug. 18. He was 69 years old. After his graduation from Carlton College in 1887 he engaged in railroad engineering, becoming chief engineer of the Puget Sound & Willapa Harbor line of the C. M. & St. P. Railroad in 1907. In 1917 he was commissioned in the 18th Regiment of Engineers of the United States Army.

EDWARD B. GREEN, Jr., architect of Buffalo, N. Y., who designed the University of Buffalo buildings, died suddenly August 15 at the age of 45. He also designed the Dayton Art Institute, the Toledo Museum of Art and at the time of his death was preparing plans for the Lockwood Memorial Library. He formerly served on the City Planning Committee and recently was appointed to the district committee of the National Recovery Act.

SAMUEL FORTIER, professor of irrigation at the University of California and former chief of the irrigation investigation bureau of the United States Department of Agriculture, died at Oakland, Calif., on Aug. 19 at the age of 78. Dr. Fortier was born in Leeds, Que., but most of his professional work was performed in the United States. In 1886 he entered the employ of the Denver Water Company. Several years later he served as hydrographer for the United States Geological Survey and as consulting engineer for irrigation enterprises. In 1903 he was placed in charge of the Pacific Coast District of the irrigation investigations of the United States Office of Experimental Stations and from 1907 to 1915 was chief of irrigation investigation. In 1924 he was appointed senior irrigation engineer for the Department of Agriculture, becoming associate chief of the Division of Agricultural Engineering. He retired from the federal service in 1925.

Engineering Contracts and Capital

INCREASED activity in highway lettings and heavy awards for waterworks raised the total of heavy engineering construction contracts reported last week to $15,961,000, the largest contract figure recorded in nine weeks. Public works, which have been averaging slightly better than $6,000,000 for several weeks, jumped to $10,995,000. Meanwhile, private contracts slumped to $4,966,000 for the week after holding close to 7 millions for several weeks. Highway lettings, $4,737,000, constituted the largest item of last week's awards. This total has been exceeded only three times this year, though last year road awards passed $15,000,000 several weeks. Federal awards amounted to $1,935,000, the heaviest since early April, when the ban on new government construction went into effect. A 2½-million dollar water main contract in Cleveland raised the waterworks class to $2,817,000 for the week, the highest total of the year exclusive of the Colorado River aqueduct awards. The cumulative total of contracts awarded this year to date is $551,221,000, about 69 per cent of last year's volume for a similar period.

New capital issues reported last week total $55,394,000, including a $44,000,000 loan to New York City for the construction of the Triborough bridge. Several bond sales were reported by municipalities for construction purposes. Private issues for the week amounted to $8,765,000, the largest figure for this class since February of this year.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

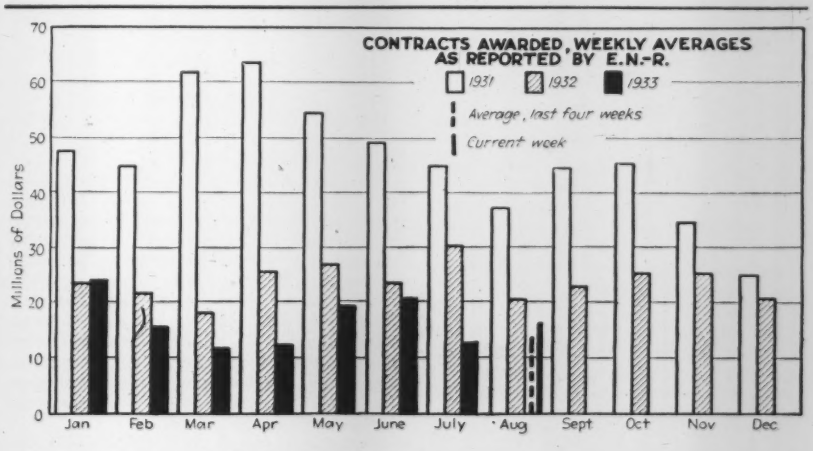
	Weekly August, 1932	Average Four Weeks	Week Aug. 24, 1933
Federal Government	$4,177	$639	$1,935
State and municipal	12,440	6,356	9,060
Total public	$16,617	$6,995	$10,995
Total private	3,792	6,811	4,966
Week's total	$20,409	$13,806	$15,961
Cumulative to date:			
1932		$800,207	
1933		551,221	

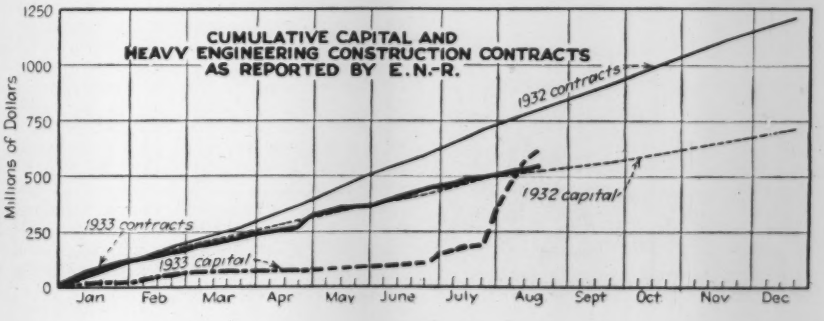
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly August 1932	Average Four Weeks	Week Aug. 19, 1933
New capital issues	$5,400	$110,746	$55,394
Cumulative to date:			
1932		$512,200	
1933		626,235	

ENR Cost and Volume Index

E.N.-R. Cost		E.N.-R. Volume	
August, 1933	167.00	July, 1933	65
July, 1933	165.50	June, 1933	109
August, 1932	156.80	July, 1932	166
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 Average	100		





Construction Equipment and Materials

Scraper and Sheepsfoot Roller Combined in New Machine

A new hook-up of scraper and sheepsfoot roller is announced by R. G. LeTourneau, Inc., of Stockton, Calif. The maker states that it tamps and compacts fills automatically.

The scraper-roller was developed for use on fills where extreme compaction is required, or where it is desired to dispense with the use of a separate sheepsfoot roller. In operation, it is mounted rigidly behind the rear wheels of a scraper in such a manner as to be clear of the ground when the scraper is being loaded or when it is carrying its load. When the scraper arrives on the fill and the scraper blade is raised for dumping, the sheepsfoot roller automatically takes the load off the rear wheels and begins its tamping work. Because the dumping is always done in this position, the roller is in action as long as the scraper is on the fill. As the scraper leaves the fill, its blade is lowered and the weight is again carried on the rubber-tired wheels when the sheepsfoot roller automatically leaves the ground.

Scraper-roller combination for use on fills needing great compaction

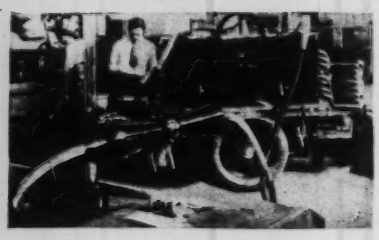
Portable X-Ray Equipment For Industrial Use

The Industrial X-Ray Corp., Los Angeles, Calif., through an arrangement with the N. V. Philips Corp., of Holland, announces the introduction of portable industrial X-ray equipment, the Metalix X-ray apparatus.

The Metalix machines are designed to X-ray wood, steel, metal, concrete, clay products, textiles and other materials. The apparatus consists of a high voltage generator, constructed in a metal container; a control box built against this container incorporating the necessary switches and regulating and measuring controls; and two shock-proof high voltage cables which connect the transformer to the ray-proof and shock-proof Metalix tube.

The company states that with the Metalix apparatus only the primary useful beam of X-ray is emitted and that biologically harmful rays are absorbed at the source. The apparatus eliminates both unwanted radiation and the necessity of working with high tension wires.

Metalix X-Ray apparatus



New Equipment in Brief

Insulating Lath. A single thickness of fibre-board insulating lath 1½ in. thick is announced by the Armstrong Cork & Insulation Co., Lancaster, Pa. This new thickness is the latest addition to the line of Temlok insulation products distributed by the company.

Pipe Fittings. Taylor Forge & Pipe Works, Chicago, Ill., announces a new line of light weight fittings manufactured of No. 10 gage steel. They are furnished plain end or flanged, or flanged one end only. They are suitable for hydraulic pressures of 200 lb. per sq.in.

Bar Iron. The Reading Iron Co., 401 N. Broad St., Philadelphia, Pa., announces the development of a special grade of bar iron which is recommended for service where extremely severe hvibration is encountered. The iron is said to possess a high resistance to failure due to vibration or fatigue, and to impact or shock stresses.

Ventilating Fan. A new ventilating fan built by Buffalo Forge Co., Buffalo, N. Y., has been specially designed to give quiet operation. To remove the last traces of motor hum, which normally is picked up and magnified by the fan base and foundations, a new silent floating base was designed. This provides a means of insulating a fan and its driving motor from building foundations.

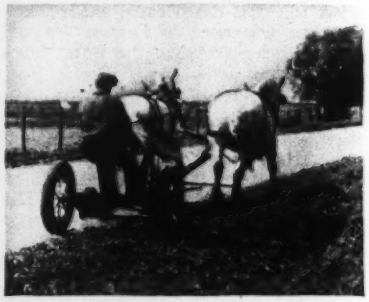
Altitude Regulator. The Electric Controller & Manufacturing Co., Cleveland, Ohio, announces a new altitude regulator to be used in connection with automatic control of motor driven pumps. The maker states that the regulator is very sensitive in operation, being so designed that it is possible to obtain close regulation of water and liquid levels. The regulator is enclosed in a bakelite case. Adjustment of the contacts is obtained through individual flush-type adjusting screws located at the bottom part of the cover.

Tension Indicator. The Martin-Decker Corp., Long Beach, Calif., announces its shunt type tension indicator, for measuring the tension in wires or cables. In operation a fluid body behind a flexible diaphragm balances the pressure required to make a slight offset in the lines between two fixed points. The pressure is a direct measure of the load on the line. The manufacturer states that the instrument is accurate within a range of 2 per cent. Two instruments, one a standard and the other a heavy-duty model, will measure the strain on any wire or cable, from ¼ in. to 2⅜ in. in diameter, capacity ranges up to 260,000 lb.

Enclosed-Gear Mower Made with Balloon Tires

The International Harvester Co., Chicago, Ill., has announced that the recently developed McCormick-Deering enclosed gear mower is now available with balloon tires for use in mowing shoulders along hard-surfaced highways.

The balloon tires are 5¼x21 in. and fit over conventional automobile-type rims. The ratchets of the enclosed-gear mower are inside a gear box filled with oil. The main axle, to which the wheels are solidly keyed, is made in two sections, and these are connected by a differential arrangement inside the gear box.



McCormick-Deering mower, with balloon tires

New Publications

Reduction Gears. Poole Foundry & Machine Co., Baltimore, Md., has issued a new reduction-gear catalog describing the Poole single, double and triple herringbone gear units. For each type and size of unit there are provided data on dimensions, weight, horsepower ratings, speeds and ratios.

Graders. The Austin-Western Road Machinery Co., Chicago, Ill., has published bulletins 1296, 1297, 1298 and 1299, describing the company's model "77" motor grader with dual drive and hydraulic control, dual drive hand operated, single drive hydraulic control, and single drive hand control.

Power Shovels. Bay City Shovels, Inc., Bay City, Mich., has just issued catalog 42-A which contains detailed specifications, working range diagrams and illustrations of their new model 42, standard ¾-yd. full-revolving convertible shovel. This machine is rated as a 10-ton crane and in addition to shovel is available with clamshell, dragline or trench hoe buckets.

Air Compressors. The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has published their leaflet 2159 which describes the new single-stage water-cooled rotary air compressors. This covers a complete line of rotary air compressors and vacuum pumps of the multicellular, sliding-vane type, having a range of volumes from 50 to 2000 cu.ft. per min., at pressures up to 150 lb. and vacuums up to 29.85 in. mercury.

Metallizing Process. The Metallizing Co. of America, Inc., 1218 Long Beach Ave., Los Angeles, Calif., has published a 20-page booklet covering the metallizing process, its applications, advantages, and accessory equipment. The metallizing process is a method of spraying molten metal so that it will adhere to practically any solid base. Glass, wood, plaster, cloth, cement, paper, plaster of paris, brick, tile and metal can be coated with metal by this method.

Steel Floors. A 24-page booklet describing the Belmont rolled structural-steel interlocking channel floor has been issued by the Belmont Iron Works, Philadelphia, Pa. The floor described is an assembly of rolled structural steel channels or other shapes, placed alternately flanges up and flanges down, with the flanges interlocking and securely are welded. The use of the floor for highway bridge decks, railway bridge decks, pier decks, and modern building floors is described and illustrated. Data sheets for the use of the designing engineer are also included.